FLUIDYNE ENGINEERING CORPORATION

(NASA-CR-170849) PRELIMINARY ENGINEERING STUDY QUICK OPENING VALVE MSFC HIGH REYNOLDS NUMBER WIND TUNNEL (STUDY REPORT APPENDICES) Final Report (Fluidyne Engineering Corp.) 101 p HC A06/MF A01 CSCL 14B G3/09

N83-33906

Unclas 36075

# PRELIMINARY ENGINEERING STUDY
# QUICK OPENING VALVE
# MSFC HIGH REYNOLDS NUMBER WIND TUNNEL
# (STUDY REPORT APPENDICES)

by

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prepared for

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Alabama 35812

Final Report
Contract NAS8-35056
FluiDyne Project 1380

July 1983

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# APPENDIX A

# RELEASE MECHANISM CONCEPTS

# APPENDIX A
## RELEASE MECHANISM CONCEPTS

The following configurations were considered as release mechanisms for the sliding sleeve valve. The driving force is 50,000 lbs. The release should be essentially instantaneous and should present a negligible amount of resistance to movement as compared to the driving force. The concepts are described and sketched below.

1. Explosive Bolts

a. Upstream

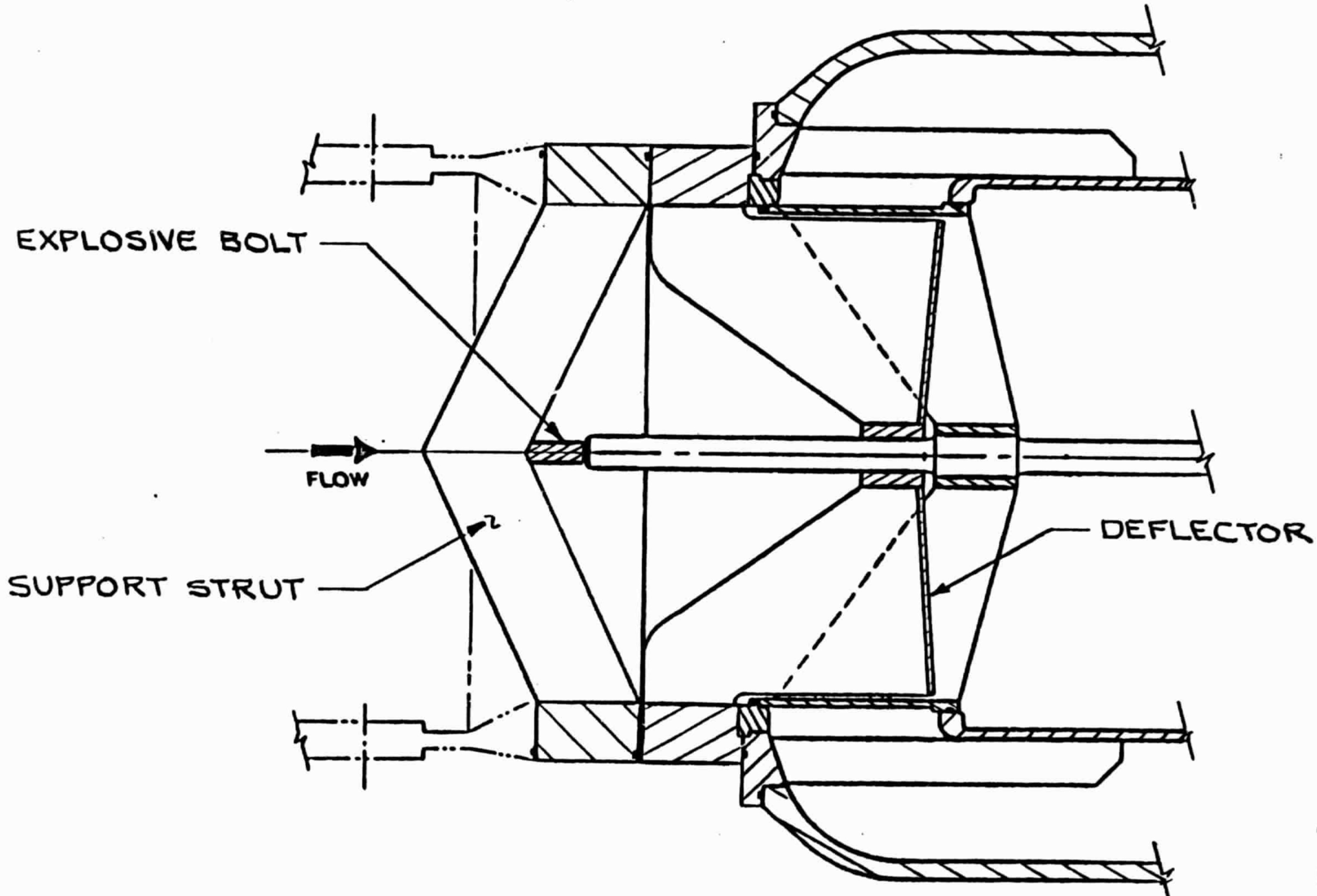
The most straight forward application of the explosive bolt is a tension bolt located at the upstream end of the actuating rod. This would be supported by a vertical strut installed in the shadow of the model support struts. Disadvantages are:

- Requirement for the supporting strut
- Possible release of gas and/or acoustical energy within the downstream end of the charge tube.

b. Downstream

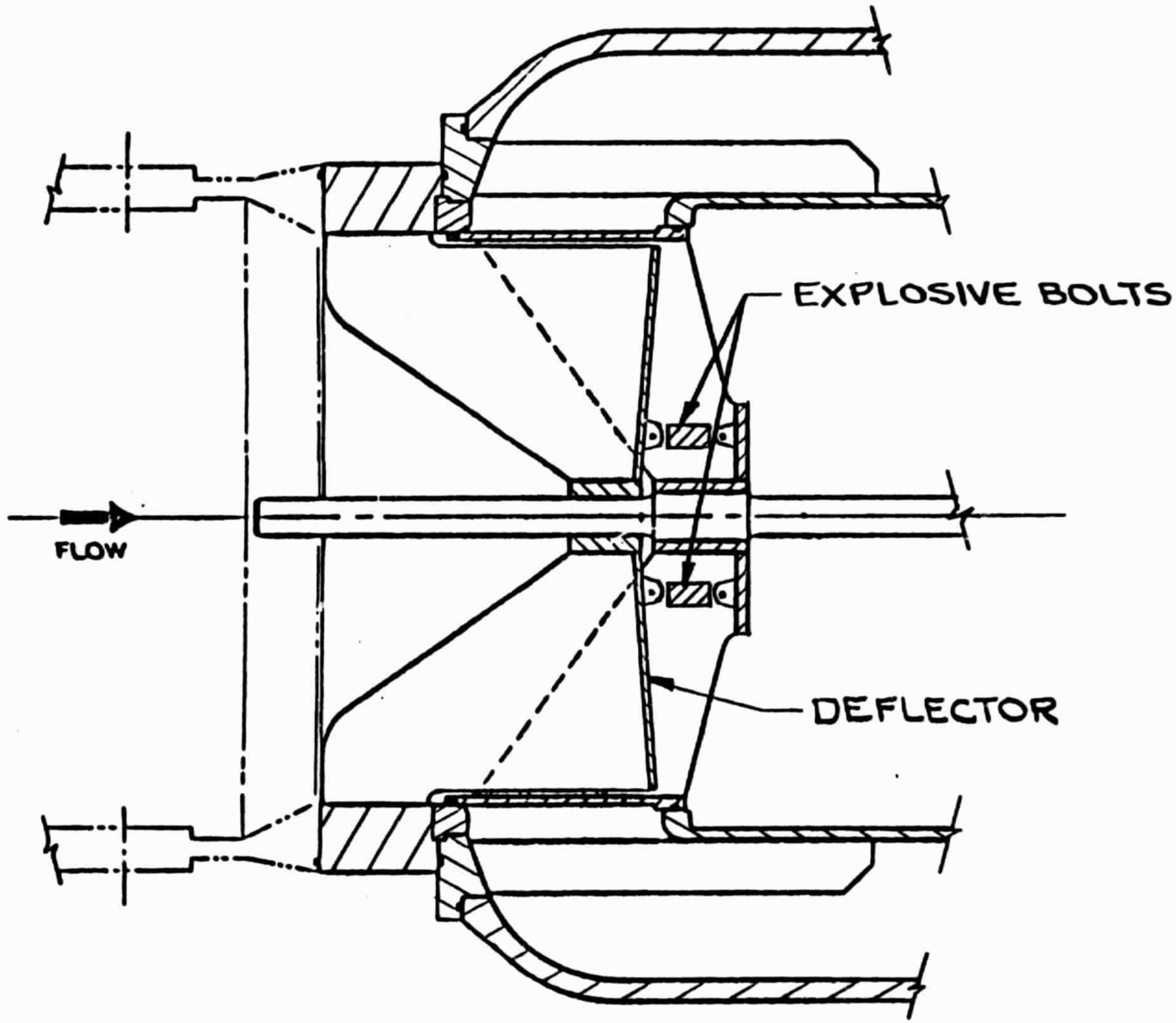
An alternate location could be just downstream of the deflector, attaching the sleeve struts to the bearing struts. This location:

- Eliminates the need for the support strut,
- Minimizes the disturbance caused by the explosive release, but
- Is difficult to reach for replacement of the bolts.




UPSTREAM LOCATION

RELEASE MECHANISM - EXPLOSIVE BOLT




DOWNSTREAM LOCATION

RELEASE MECHANISM - EXPLOSIVE BOLTS

2. Hydraulic Release

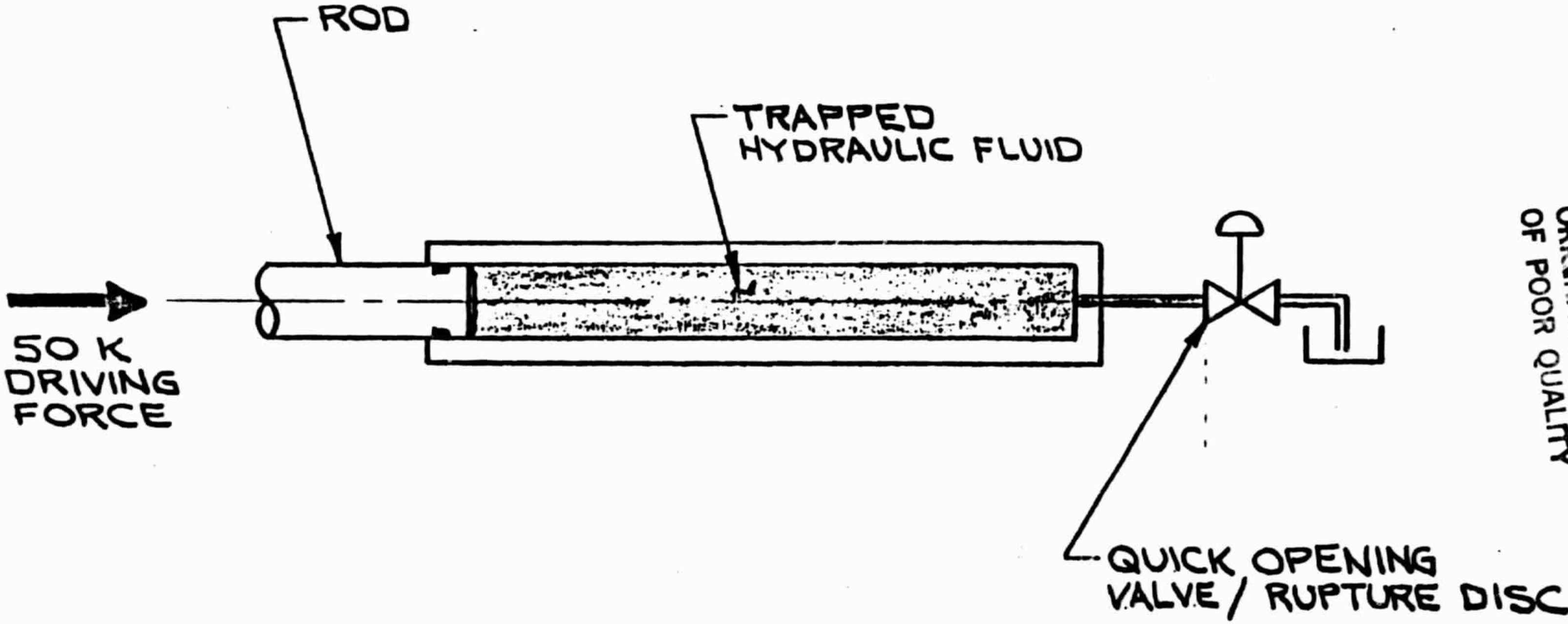
a. Rod

This concept involves quickly releasing a trapped hydraulic volume which restrains the actuation of the sleeve. The release could be by means of a quick acting valve or the release of a rupture disc. Two opposing factors influence the design:

- The desire to keep the trapped pressure low by using a large pressure area, and

- The desire to limit flowrate (i.e., size of the valve/rupture disc) by using a small pressure area.

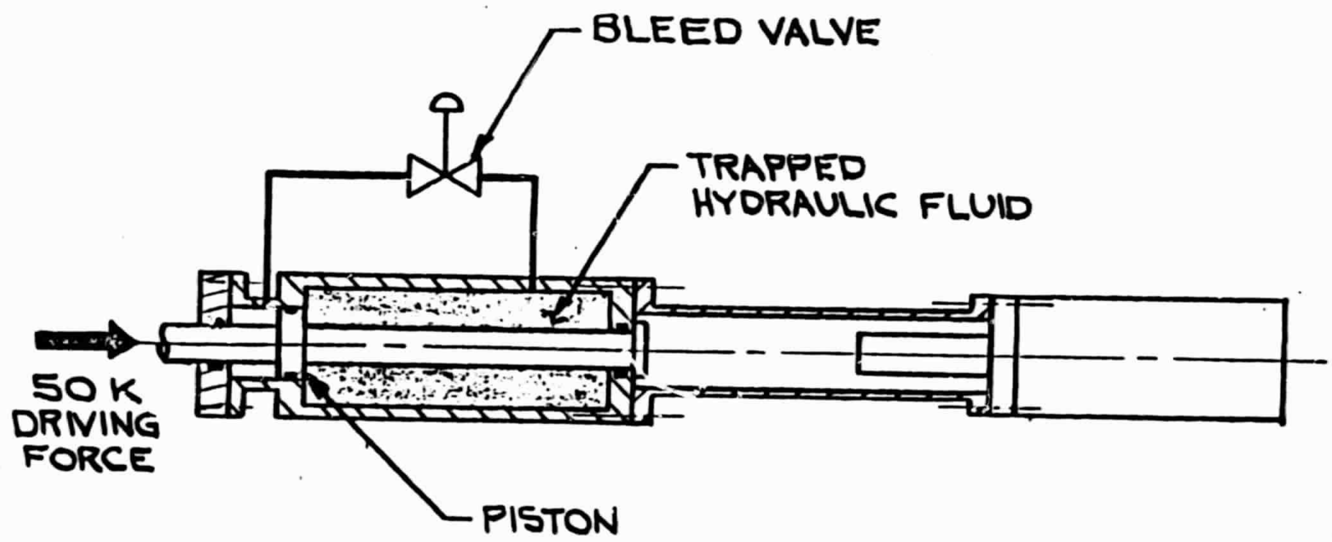
A preliminary sizing uses a 3 inch diameter pressure area which results in a fairly high (6,500 psi) hydraulic pressure. Maximum flow rate at the end of the opening cycle exceeds 1,100 gpm which results in impractical valve/disc sizes for this application. Space considerations and leakage at these pressure levels are major concerns.




ROD RELEASE MECHANISM - HYDRAULIC

b. Secondary Piston

A variation of the above hydraulic release mechanism involves allowing fluid to flow around a secondary piston on the actuator rod. The motion is initiated by bleeding a small amount of fluid around the piston via a valve. When the piston clears the restricted diameter the resistance to flow around the piston drops to near zero, and tha movement is essentially free. Seal configuration and leakage are again major concerns.

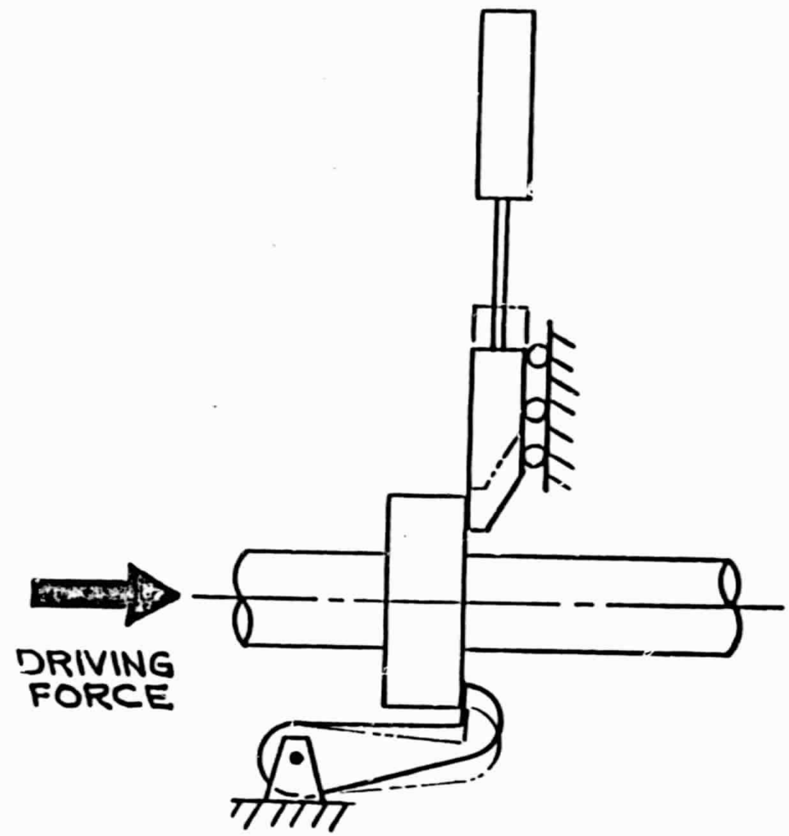



PISTON

RELEASE MECHANISM - HYDRAULIC

3. Toggles, Latches

Mechanical toggles and latches are often used as release mechanisms. This application, however, is out of the ordinary because of the magnitude of the driving force (50,000 lbs). As the toggle/latch moves the final distance before releasing, the contact stresses far exceed yield strengths and the surfaces are damaged.

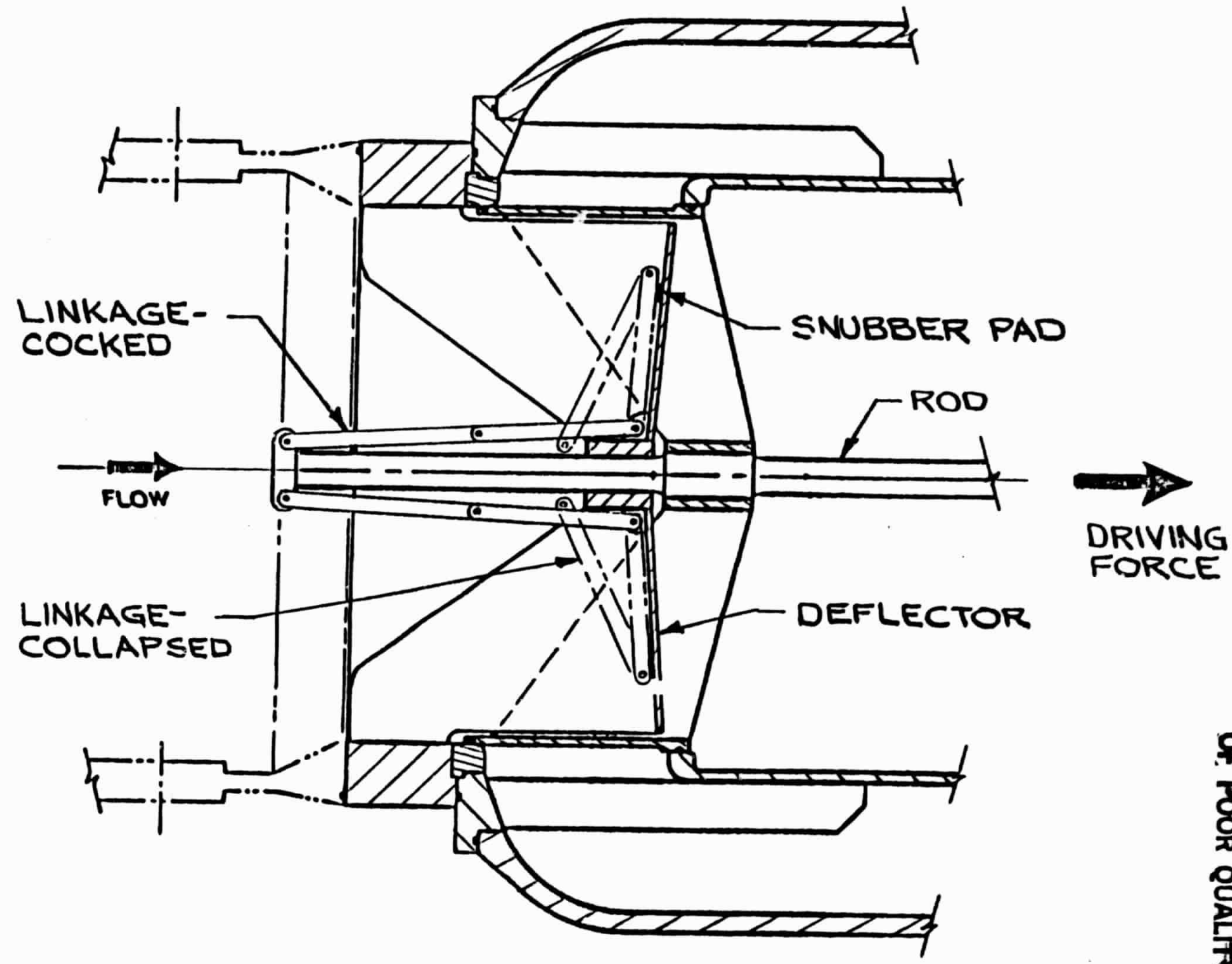



TOGGLES / LATCHES
RELEASE MECHANISM

4. Overcenter Linkage

A two bar linkage used as a compression column is a possible release mechanism. In the cocked position the center pivot is against a stop, slightly beyond the in-line position established by the end pins. A small force is used to kick this pin away from the stop, and as it passes center, the linkage is free to collapse. The dynamics of the links and pins must be carefully investigated and a method of initiation selected.

E1380-A




OVER CENTER LINKAGE
RELEASE MECHANISM

# APPENDIX B

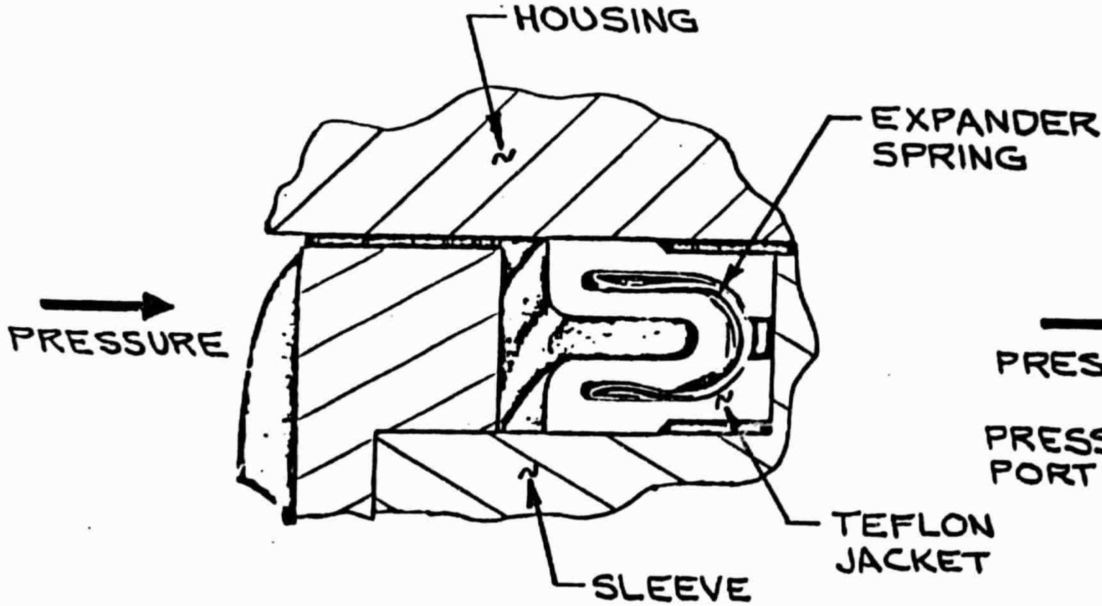
# SEAL CONCEPTS

# APPENDIX B
## SEAL CONCEPTS

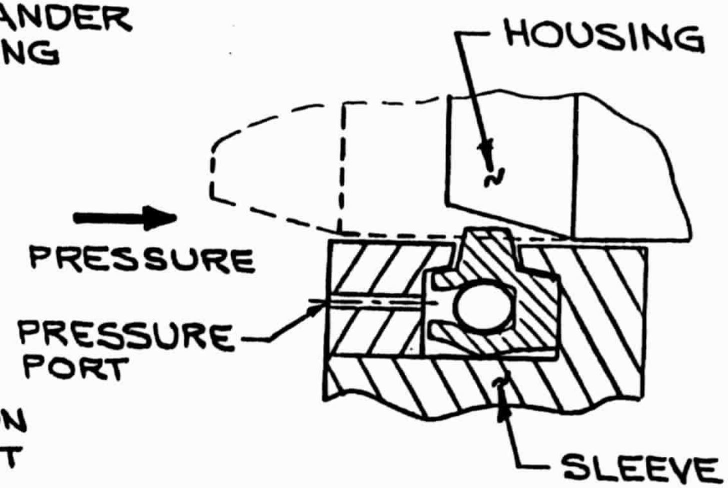
The following seal configurations were considered for use in sealing the sliding sleeve to the body of the quick opening valve. The sealing pressure is 650 psi. The seals slide a short distance (approximately 1 inch) on the mating surface before clearing the surface for the remainder of the travel. The sleeve is reset to the closed (sealed) position with zero differential pressure. The concepts are described and sketched below.

a. "U" Shaped, Spring Expander Seal

This seal is composed of a "U" shaped reinforced teflon jacket surrounding a stainless steel expander spring. The seal is positioned in a groove with the open end of the seal facing the pressure. The pressure expands the "U" to increase the sealing capability, thus making it self-energizing. The main problem with this seal occurs as the sleeve travels and the seal moves away from the sealing surface. As this occurs the pressure tends to blow out the sealing leg of the "U". A modification of this concept is the anti-blowout seal which has a lip on the seal groove to retain the sealing leg against blowout.




CONVENTIONAL SEAL

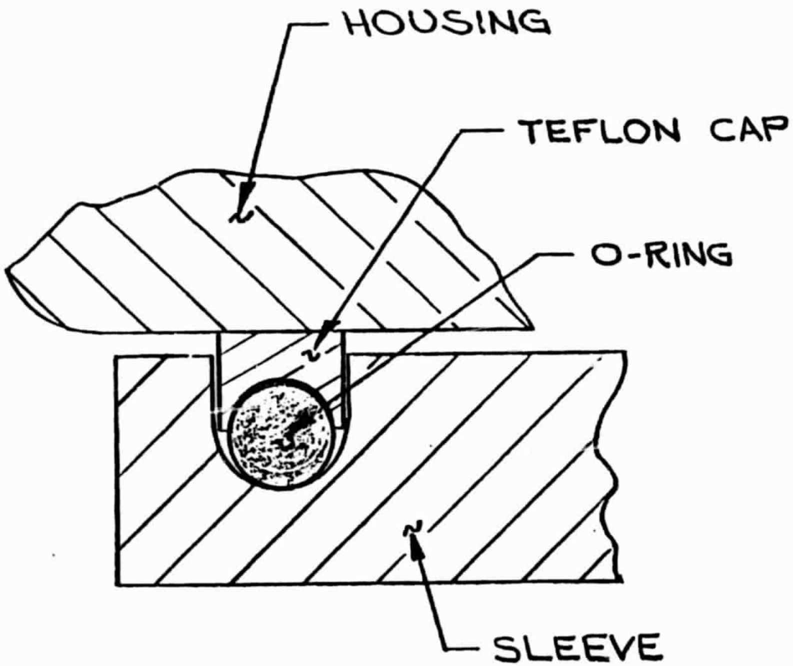



ANTI BLOW-OUT SEAL

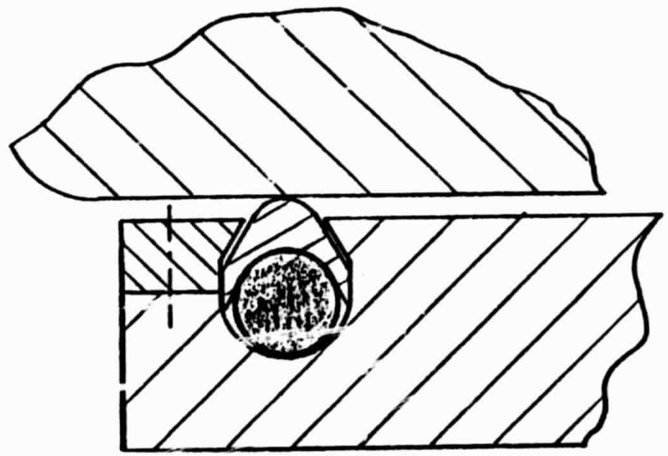
"U" SHAPED SPRING EXPANDED SEAL

b. Cap Seal

This seal is composed of a teflon cap strip with an O-ring expander. One version uses a straight sided groove, and depends on the hoop strength of the teflon cap to prevent blowout when moving away from contact with the housing. Another version has a V-shaped top and is contained in the groove by the angled lips of the groove. These seals are not basically pressure energized and must depend mainly on the resilience of the o ring to create the force against the sealing surface.




CONVENTIONAL



CAPTURED

CAP SEALS

c. Seat Seal

Various versions of resilient seat seals are used in valve applications. These are usually composed of a fixed resilient seat into which a valve plug or needle is driven. The contact is usually angular or face contact such that the further the plug is moved, the better the sealing. A major difficulty in this application is that two sealing locations must contact and seat simultaneously. In other words, the axial position of the sealing surface and seat at each location is critical to the effectiveness of the sealing. Fabrication tolerances, sleeve axial position and wear all affect this positioning.

# APPENDIX C

# VENDOR CONTACTS

ORIGINAL PAGE IS
OF POOR QUALITY

FURNISHED LARGE VALVE FOR ASTF.

INFORMATION ON TELEPHONE CONTACT

Date: 12 & 16 MAY 83 Company: AXEL JOHNSON CO

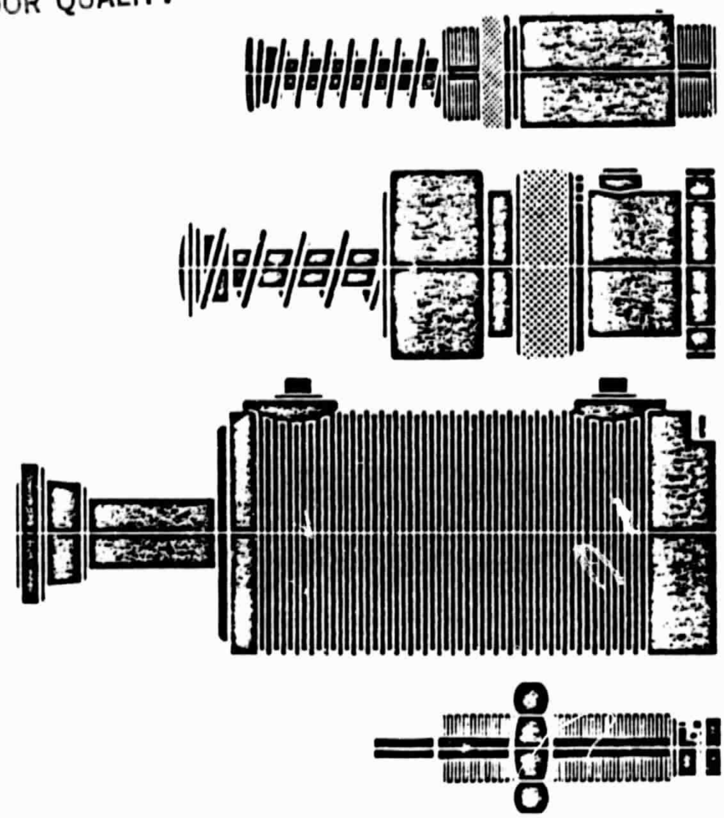
Individual Contacted: ERIC LELAND & HARRY SHIN 415-777-3800

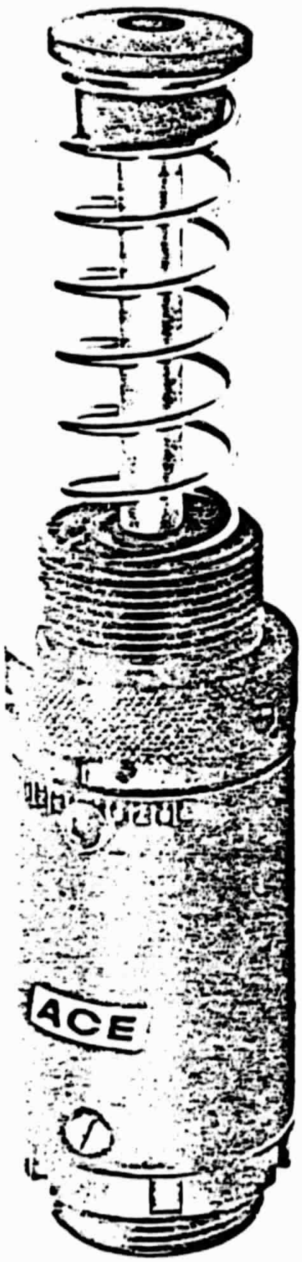
Distribute Copies: Job No: 1380

FluiDyne Contact: HAMRE

Summary: CONTACT RE 48" - 650 PSI TIGHT SHUTOFF VALVES - AMBIENT TEMP. AIR, ~2 TO 3' LENGTH, ~10 SEC OPERATING TIME, ~25% MAX BLOCKAGE.

1. B.F. VALVE FOR THIS PRESS & SIZE IS DOUBTFUL BECAUSE OF DISC THICKNESS. A FLOW THRU DISC (TRUSS STIFFENED) MAY BE HELPFUL, HOWEVER OPERATING TORQUE COULD DOUBLE. AN INFLATABLE SEAL MAY REDUCE SEATING TORQUE.
2. BEST CHOICE IS BALL VALVE (~96" LONG, NEXT WOULD BE GATE VALVE (SPECIAL BODY W/O FLANGES WOULD REDUCE LENGTH).
3. THEY DO NOT APPEAR INTERESTED IN CUSTOM DESIGN AND SUGGESTED WE CONTACT GROVE (415/655-7700) FOR THEIR G-4 GATE & B-5 BALL VALVES.
4. SHIN ESTIMATES A 12" THICK DISK FOR B.F. VALVE & 12,000 PSI STRESSES.






INDUSTRIAL
SHOCK
ABSORBERS

The proven linear deceleration
approach to increase
useful life and productivity
of machines and
industrial equipment

ACE **controls inc.**

Originators and manufacturers of
hydraulic Adjust-A-Shock® absorbers for industry.

**ORIGINAL PAGE IS OF POOR QUALITY**

| STROKE / BORE SIZE | DIMENSION "A" OVERALL LENGTH | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in. | ½ | 1 | 2 | 3 | 3½ | 4 | 5 | 6 | 6½ | 8 | 10 | 12 | 15 |
| mm | 12.7 | 25.4 | 50.8 | 76.2 | 88.9 | 101.6 | 127 | 152.4 | 165.1 | 203.2 | 254 | 304.8 | 381 |
| in. ¼ | 3 13/16 | | | | | | | | | | | | |
| mm 6.3 | 97 | | | | | | | | | | | | |
| in. ⅜ | | 4¾ | | | | | | | | | | | |
| mm 9.5 | | 121 | | | | | | | | | | | |
| in. ⅝ / mm 15.9 | | REFER TO SEPARATE LITERATURE FOR SPECIFICATIONS & SIZING | | | | | | | | | | | |
| in. ½ | | 5 7/16 | 7 7/16 | | | | | | | | | | |
| mm 12.7 | | 138 | 189 | | | | | | | | | | |
| in. ¾ | | 5 23/32 | 7 23/32 | 9 23/32 | | | | | | | | | |
| mm 19.1 | | 145 | 196 | 247 | | | | | | | | | |
| in. 1⅛ | | | 8⅞ | | | 12⅞ | | 17¼ | | | | | |
| mm 28.6 | | | 225 | | | 327 | | 438 | | | | | |
| in. 1½ (a) | | | 8 3/32 | | 11⅛ | | 14⅛ | | 17⅞ | | | | |
| mm 38.1 | | | 206 | | 283 | | 359 | | 454 | | | | |
| in. 1½ (b) FOUNDRY SERIES | | | | | 11⅞ | | 14⅞ | | 17⅞ | 20⅞ | 24⅞ | | |
| mm 38.1 | | | | | 302 | | 378 | | 454 | 530 | 632 | | |
| in. 2 AHS MODELS ONLY | | | 12 5/16 | | | 16 5/16 | | 20 5/16 | | 24 5/16 | 28 5/16 | | |
| mm 50.8 | | | 313 | | | 414 | | 516 | | 618 | 719 | | |
| in. 2 SAHS MODELS ONLY | | | 12 5/16 | | | 16 5/16 | | 20 5/16 | | 25 5/16 | 29 5/16 | | |
| mm 50.8 | | | 313 | | | 414 | | 516 | | 643 | 744 | | |
| in. 3 (b) | | | | | | | 17¼ | | | 23¼ | | 33 1/32 | |
| mm 76.2 | | | | | | | 438 | | | 591 | | 839 | |
| in. 4 AHS MODELS ONLY | | | | | | | | 24 23/32 | | 28 23/32 | | | |
| mm 101.6 | | | | | | | | 628 | | 729 | | | |
| in. 4 SAHS MODELS ONLY | | | | | | | | 26 23/32 | | 30 23/32 | | | |
| mm 101.6 | | | | | | | | 679 | | 780 | | | |
| in. 5 (c) AHS MODELS ONLY | | | | | | | 23⅞ | | | | 33⅞ | | 43⅞ |
| mm 127 | | | | | | | 606 | | | | 860 | | 1114 |
| in. 5 (c) SAHS MODELS ONLY | | | | | | | 28⅞ | | | | 38⅞ | | 48⅞ |
| mm 127 | | | | | | | 733 | | | | 987 | | 1241 |

| STROKE / BORE SIZE | MOUNTING DIMENSIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B† | C* | D | | E | | F | | G | | H |
| | Dia. | | Sq. | Rect. | Sq. | Rect. | Sq. | Rect. | Sq. | Rect. | Dia. |
| in. ¼ | 21/32 | | | | 1 ⅛ Hex. | | | | | | |
| mm 6.3 | 17 | | | | 29 | | | | | | |
| in. ⅜ | 29/32 | | | | 1⅛ Hex. | | | | | | |
| mm 9.5 | 23 | | | | 29 | | | | | | |
| in. ⅝ / mm 15.9 | | | | | | | | | | | |
| in. ½ | 1½ | 2¼ | 1½ | | 1⅛ | | 2 | | 1⅝ | | 7/32 |
| mm 12.7 | 38 | 57 | 41 | | 28 | | 54 | | 42 | | 7 |
| in. ¾ | 2¼ | 2¾ | 2¼ | 3 | 1⅝ | 2⅜ | 2¼ | | 1⅝ | | 11/32 |
| mm 19.1 | 57 | 70 | 57 | 76 | 41 | 60 | 57 | | 41 | | 9 |
| in. 1⅛ | 3 | 3½ | 3½ | | 2¾ | | 3½ | | 2¾ | | 13/32 |
| mm 28.6 | 76 | 89 | 89 | | 70 | | 89 | | 70 | | 10 |
| in. 1½ (a) | 4 | 3 9/16 | 4 | 5 | 3 | 4 | 4 | 4 | 3 | 3 | 17/32 |
| mm 38.1 | 102 | 90 | 102 | 127 | 76 | 102 | 102 | 102 | 76 | 76 | 14 |
| in. 1½ (b) FOUNDRY SERIES | 4 | 4 5/16 | 4 | 5 | 3 | 4 | 4 | 4 | 3 | 3 | 17/32 |
| mm 38.1 | 102 | 109 | 102 | 127 | 76 | 102 | 102 | 102 | 76 | 76 | 14 |
| in. 2 AHS MODELS ONLY | 5 | 6 | 5½ | | 4⅜ | | 5½ | | 4⅜ | | 21/32 |
| mm 50.8 | 127 | 152 | 140 | | 111 | | 140 | | 111 | | 17 |
| in. 2 SAHS MODELS ONLY | 6 | 6 | 5½ | | 4⅜ | | 5½ | | 4⅜ | | 21/32 |
| mm 50.8 | 152 | 152 | 140 | | 111 | | 140 | | 111 | | 17 |
| in. 3 (b) | 8 | 6 | 6 | 6½ | 4⅞ | 4½ | 6½ | 8 | 5⅜ | 6½ | 21/32 / 25/32 |
| mm 76.2 | 203 | 152 | 152 | 165 | 124 | 114 | 165 | 203 | 137 | 165 | 17 / 20 |
| in. 4 AHS MODELS ONLY | 8½ | 11¼ | 10 | | 8 | | 10 | | 8 | | 1 1/16 |
| mm 101.6 | 216 | 286 | 254 | | 203 | | 254 | | 203 | | 27 |
| in. 4 SAHS MODELS ONLY | 8½ | 11¼ | 10 | | 8 | | 10 | | 8 | | 1 1/16 |
| mm 101.6 | 216 | 286 | 254 | | 203 | | 254 | | 203 | | 27 |
| in. 5 (c) AHS MODELS ONLY | 8 | 12 | 10 | | 8 | | 10 | | 8 | | 1 1/16 |
| mm 127 | 203 | 305 | 254 | | 203 | | 254 | | 203 | | 27 |
| in. 5 (c) SAHS MODELS ONLY | 8½ | 12 | 10 | | 8 | | 10 | | 8 | | 1 1/16 |
| mm 127 | 216 | 305 | 254 | | 203 | | 254 | | 203 | | 27 |

a) ADD 1 9/16" TO "A" DIM. WHEN SPECIFYING OPTIONAL BUTTON
b) ADD 2" TO "A" DIM. WHEN SPECIFYING OPTIONAL BUTTON
c) ADD 2½" TO "A" DIM. WHEN SPECIFYING OPTIONAL BUTTON

† "B" DIMENSION IS ALWAYS LARGEST DIAMETER

* "X" DIM. = "A" DIM. MINUS "C" DIM. MINUS STROKE.

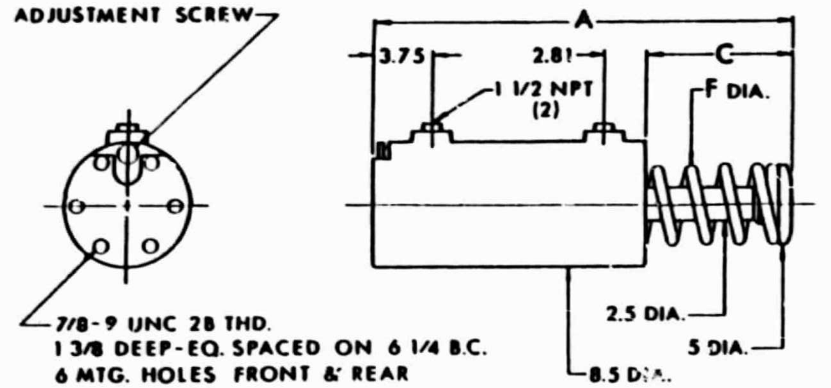
NOTE: METRIC DIMS. ROUNDED OFF TO NEAREST WHOLE MILLIMETER.

| Bore X Stroke | Maximum Inch Pounds Per Cycle | Maximum Inch Pounds Per Hour: Air/Oil | Maximum Inch Pounds Per Hour: Self Contained |
|---|---|---|---|
| 1/4 x 1/2 | 100 | — | 400,000 |
| 3/8 x 1 | 300 | 400,000 | 320,000 |
| 1/2 x 1 | 1,000 | 1,300,000 | 750,000 |
| 1/2 x 2 | 2,000 | 1,400,000 | 870,000 |
| 3/4 x 1 | 2,300 | 1,600,000 | 1,100,000 |
| 3/4 x 2 | 4,600 | 2,000,000 | 1,300,000 |
| 3/4 x 3 | 6,900 | 2,400,000 | 1,600,000 |
| 1-1/8 x 2 | 12,000 | 3,000,000 | 1,500,000 |
| 1-1/8 x 4 | 24,000 | 4,000,000 | 2,000,000 |
| 1-1/8 x 6 | 36,000 | 5,000,000 | 2,500,000 |
| 1-1/2 x 2 | 10,500 | 4,000,000 | 3,200,000 |
| 1-1/2 x 3-1/2 | 18,500 | 7,000,000 | 5,600,000 |
| 1-1/2 x 5 | 26,500 | 10,000,000 | 8,000,000 |
| 1-1/2 x 6-1/2 | 34,500 | 13,000,000 | 10,400,000 |
| 1-1/2 x 8 | 42,000 | 16,000,000 | — |
| 1-1/2 x 10 | 53,000 | 19,000,000 | — |

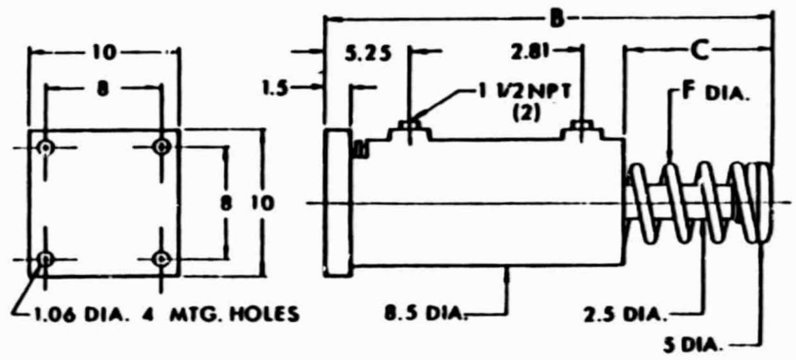
| Bore X Stroke | Maximum Inch Pounds Per Cycle | Maximum Inch Pounds Per Hour: Air/Oil | Maximum Inch Pounds Per Hour: Self Contained |
|---|---|---|---|
| 2 x 2 | 18,000 | 12,000,000 | 9,600,000 |
| 2 x 4 | 37,000 | 15,000,000 | 12,000,000 |
| 2 x 6 | 55,000 | 18,000,000 | 14,400,000 |
| 2 x 8 | 74,000 | 21,000,000 | 16,800,000 |
| 2 x 10 | 92,000 | 24,000,000 | 19,200,000 |
| 3 x 5 | 100,000 | 25,000,000 | 20,000,000 |
| 3 x 8 | 160,000 | 40,000,000 | 32,000,000 |
| 3 x 12 | 240,000 | 60,000,000 | 48,000,000 |
| 4 x 6 | 600,000 | 45,000,000 | 27,000,000 |
| 4 x 8 | 800,000 | 50,000,000 | 30,000,000 |
| 5 x 5 | 500,000 | 60,000,000 | 36,000,000 |
| 5 x 10 | 1,000,000 | 90,000,000 | 54,000,000 |
| 5 x 15 | 1,500,000 | 120,000,000 | 72,000,000 |

This table defines the energy absorbing capacity in in.-lbs. of ACE Controls' line of industrial shock absorbers. Consult factory when impact velocity is below 1 foot per second or above 10 feet per second.

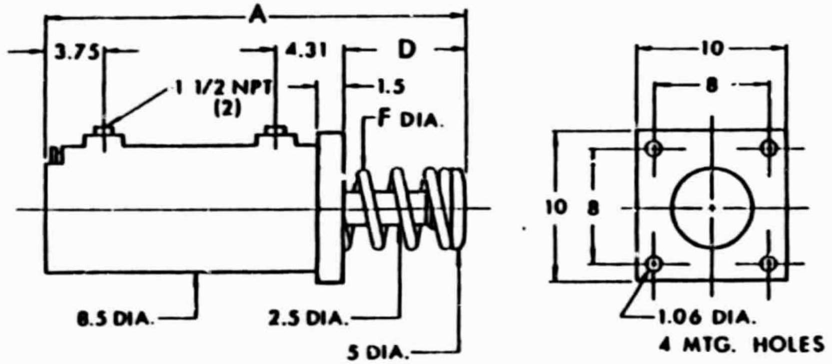
It is recommended that shock absorber selections be made at 80% of the listed capacity for inch-pounds per cycle to provide a margin for: a) Subsequent increases in weight, velocity and or propelling force for the particular application. b) The difficulty in determining exact application data, especially regarding impact velocity.



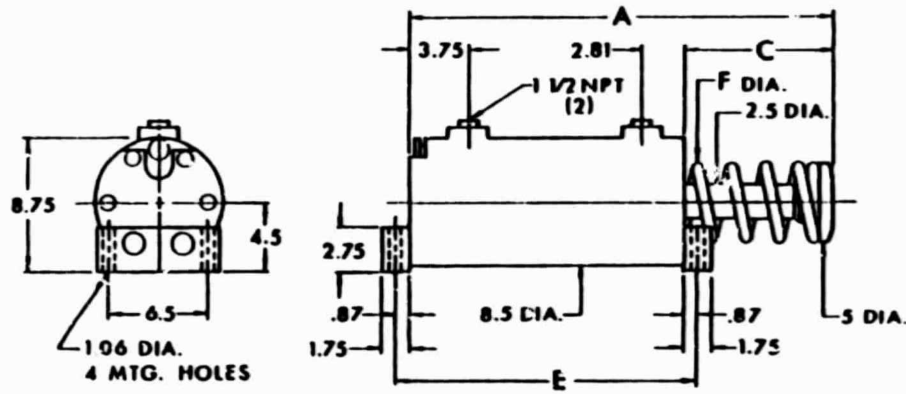

FRONT & REAR PRIMARY MOUNT MODEL NO. 4 X (STROKE)-FRP




REAR FLANGE MODEL NO. 4 X (STROKE)-R




FRONT FLANGE MODEL NO. 4 X (STROKE)-F




SIDE FOOT MOUNT MODEL NO. 4 X (STROKE)-S

| STROKE | A | B | C | D | E |
|---|---|---|---|---|---|
| 6 | 24.71 | 26.21 | 8.96 | 7.46 | 17.50 |
| 8 | 28.71 | 30.21 | 10.96 | 9.46 | 19.50 |

**AHS**
AIR RETURN MODEL
(EXTERNAL ACCUMULATOR)

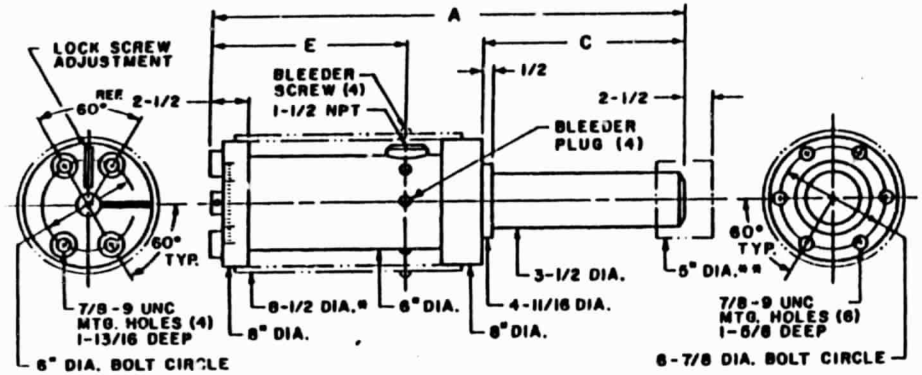
SAME DIMENSIONS AS SAHS

**AHSS**
SPRING RETURN MODEL
(SPRING & EXTERNAL ACCUMULATOR)

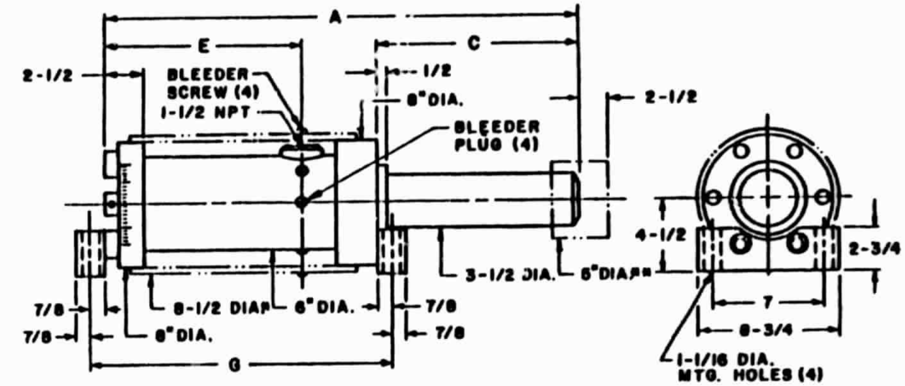
| STROKE | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 6 | 26.71 | 28.21 | 10.96 | 9.46 | 17.50 | 4.28 |
| 8 | 30.71 | 32.21 | 12.96 | 11.46 | 19.50 | 4.28 |

**SAHS**
SELF CONTAINED MODEL
(SPRING & INTERNAL ACCUMULATOR)

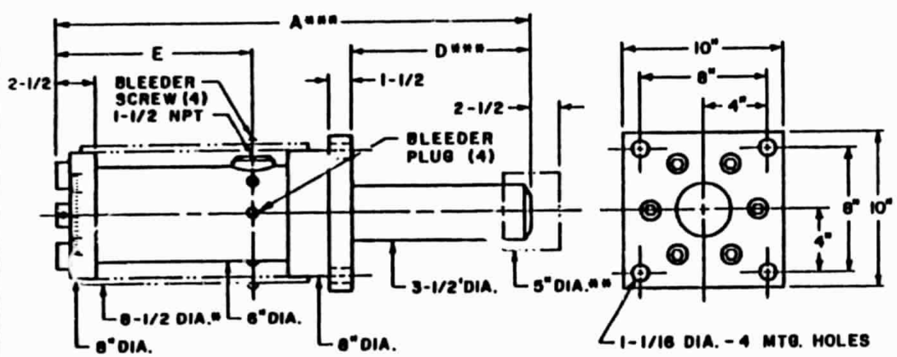
ACE controls inc. FARMINGTON, MICHIGAN U.S.A. 48024 | ADJUST-A-SHOCK® | MODEL NO. AHS AHSS SAHS 4" BORE X (STROKE)-MTG.



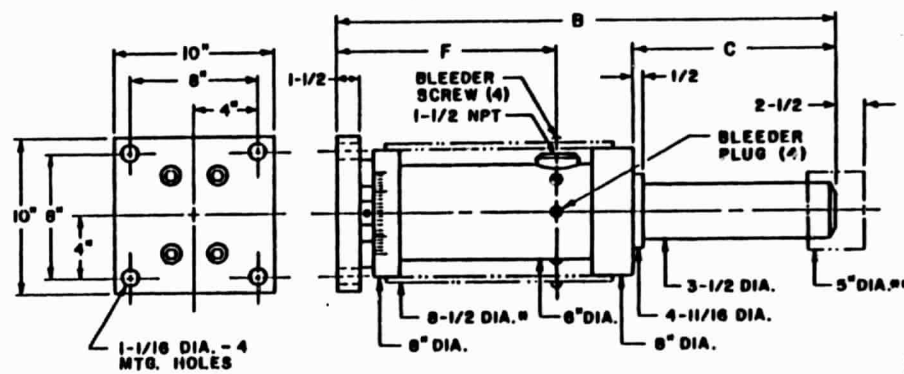

FRONT & REAR PRIMARY MOUNT MODEL - 5 x STROKE - FRP




SIDE FOOT MOUNT MODEL - 5 x STROKE - S




FRONT FLANGE MOUNT MODEL - 5 x STROKE - F




REAR FLANGE MOUNT MODEL - 5 x STROKE - R

| STROKE | A | | B | | C | | D | | E | F | G |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | AHS | SAHS | AHS | SAHS | AHS | SAHS | AHS | SAHS | | | |
| 5 | 23-7/8 | 28-7/8 | 25-3/8 | 30-3/8 | 6-7/8 | 11-7/8 | 5-3/8 | 10-3/8 | 12-1/4 | 13-3/4 | 18-3/4 |
| 10 | 33-7/8 | 38-7/8 | 35-3/8 | 40-3/8 | 11-7/8 | 16-7/8 | 10-3/8 | 15-3/8 | 17-1/4 | 18-3/4 | 23-3/4 |
| 15 | 43-7/8 | 48-7/8 | 45-3/8 | 50-3/8 | 16-7/8 | 21-7/8 | 15-3/8 | 20-3/8 | 22-1/4 | 23-3/4 | 28-3/4 |

NOTE:
* SAHS & AAHS MODELS ONLY.
** BUTTON ADDITIONAL ALL MODELS.
*** ADD 5 INCHES FOR AHS MODELS WITH BUTTON. (FOR FRONT MOUNT MODELS ONLY).

AHSS MODELS SAME DIMENSIONS AS SAHS

CLEVIS MOUNT DIMENSIONS AVAILABLE UPON REQUEST.

ACE controls inc.
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SAHS 5 x STROKE - F, R, S, & FRP

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W-K-M DIVISION

ACF INDUSTRIES INCORPORATED


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RECEIVED
JUL 1 1982
FLUIDYNE ENG. CO.

# QUOTATION

W-K-M-2109-A

| DATE | PAGE | OF |
|---|---|---|
| 7/14/82 | 1 | 1 |

QUOTATION NUMBER: H2-5393

YOUR REFERENCE: Nasa

PLEASE REFER TO QUOTATION NO. WHEN PLACING YOUR ORDER

FOR FURTHER INFORMATION CONTACT AT W-K-M LOCATION INDICATED ABOVE

Duncan E. Huff

TO:
Fluorodine
5900 Olsen Memorial Hwy.
Minneapolis, Minnesota 55422

Attention: Mr. Bob Week

SHIPPING SCHEDULE IS BASED ON CURRENT MATERIAL AVAILABILITY AND PROCUREMENT LEAD TIMES. AT TIME OF ORDER PLACEMENT AVAILABILITY OF RAW MATERIALS WILL BE CHECKED AND SHIPPING PROMISES ADJUSTED ACCORDINGLY.

| ITEM | QTY. | DESCRIPTION | UNIT PRICE | SHIPMENT |
|---|---|---|---|---|
| 1 | 1 | 48" W-K-M Saf-T-Seal Through Conduit Non-Lubricated Steel Slab Gate Valve, Figure R303RM, Class 300, T-21 trim suitable for block and bleed service in temperatures ranging from -20° F. to 250° F. maximum with pressure/temperature derating as stated in ANSI B16.5, rising stem type, raised face flanged ends, complete with Limitorque Model SMB-4-250-2 Electric Operator. (Flange to flange dimension: 87") | $81,400.00 | 27 weeks |

Notes:

1. Terms of payment are net 30 days. Interest will be charged on all past due accounts.

2. W-K-M's standard Terms and Conditions of Sale will apply.

3. Shipments are as indicated after receipt of firm order.

4. Prices quoted are net CIF Port of Entry New Orleans, Louisiana.

   Shipment given is date valve will be available for shipment ex-works IKS plant, Tokyo, Japan, and does not include ocean transit time.

   Escimated ocean transit time is 21 to 25 days from Yokohama, Japan, to New Orleans, Louisiana, contingent upon the availability of vessels departing Yokohama.

DH/db

(NEEDS HYDRAULIC OPERATOR FOR 2 TO 4 SECOND OPERATION)

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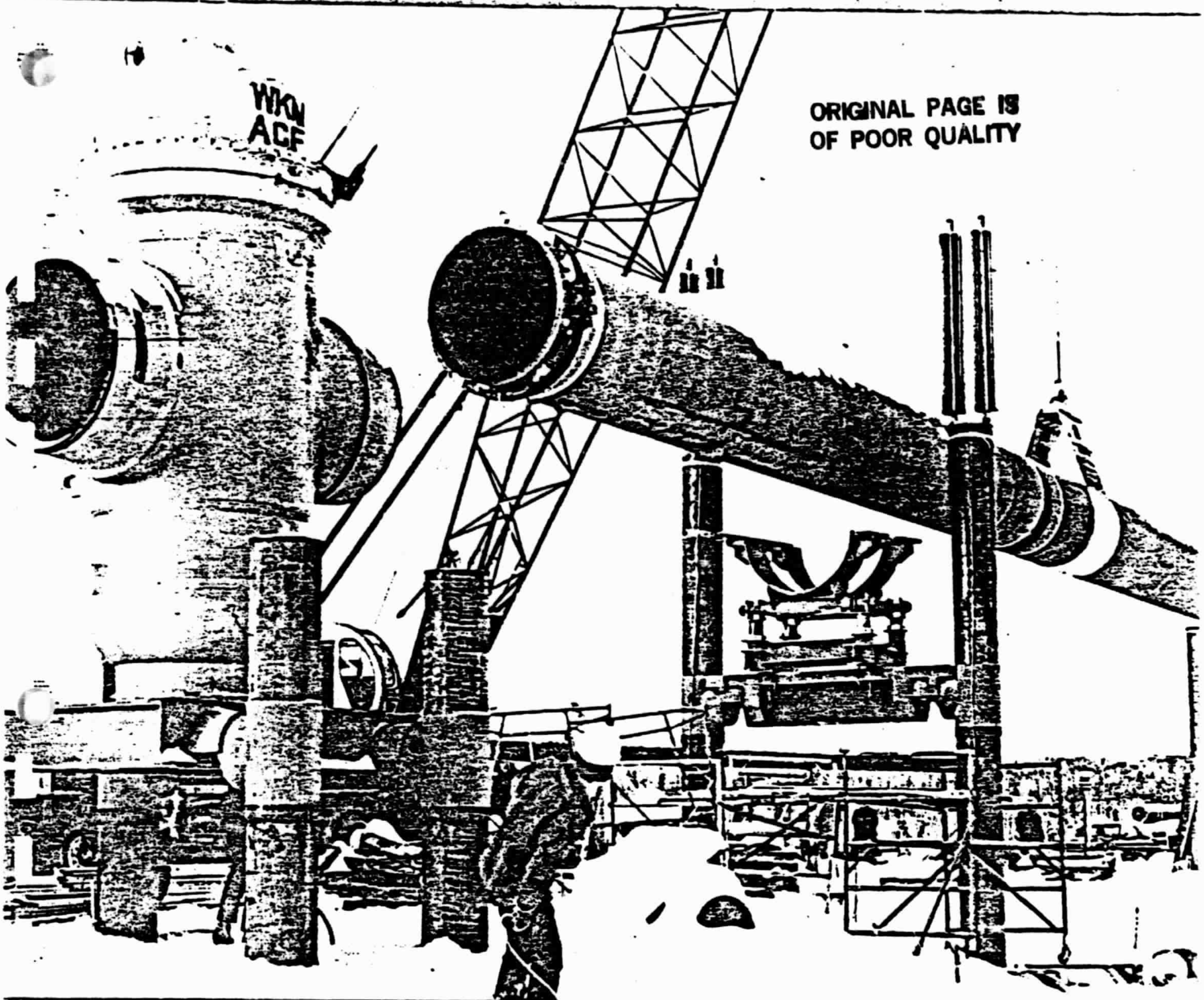


A 48-inch W-K-M Saf-T-Seal gate valve.

(Photo courtesy Alyeska Pipeline Service Corporation)

# W-K-M Saf-T-Seal Gate Valves

## Serving in flow lines, large and small . . . all over the world.

W-K-M

acf

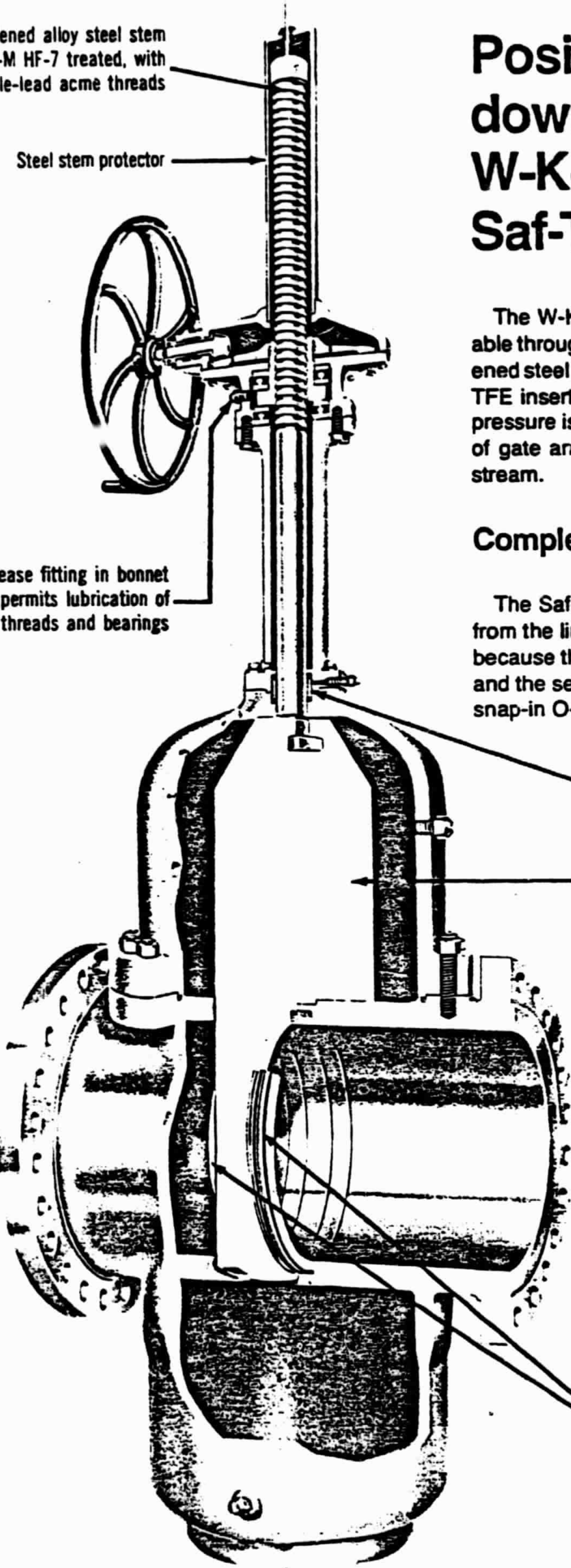
W-K-M...when the pressure's on.

# Positive upstream and downstream seal with W-K-M's through-conduit Saf-T-Seal

The W-K-M Saf-T-Seal, a simple, but rugged, efficient and reliable through-conduit gate valve, utilizes two floating seats of hardened steel to provide a complete seal with the gate. Each seat has a TFE insert in its face, plus two peripheral elastomer O-rings. As pressure is applied across the conduit opening, the floating action of gate and seats effects a tight seal both upstream and downstream.

## Completely serviceable on-line

The Saf-T-Seal can be completely serviced without removing it from the line. Replacement of seats can be readily accomplished because the bonnet connection is immediately above the conduit, and the seat is essentially one piece, with molded TFE insert and snap-in O-rings.



# Saf-T-Seal . . . in sizes from 2" through 48"

150-lb. class, handwheel operated, 2" through 12"

W-K-M Saf-T-Seal valves come in sizes from 2" through 48" . . . or larger, if needed. Most sizes are available in 150, 300, 400, 600 and 900-lb. classes. Some sizes are also available in 1500 and 2500-lb. classes. Venturi designs are also available.

Pictured are the principal standard body types in which Saf-T-Seals are manufactured. The valves are available with flange, weld and weld-by-flange ends; in some types, with female threaded end connections for the smaller sizes.

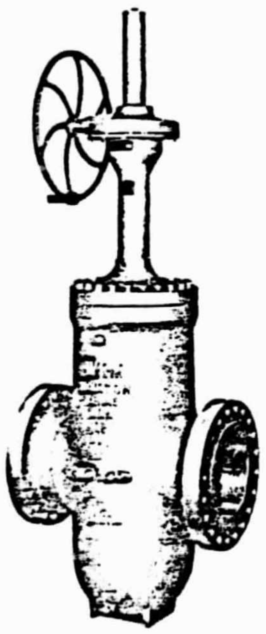
Handwheel operators are standard for 2" through 12" sizes. Bevel gear operators are optional at extra cost for 6" through 12" sizes, and are standard for larger sizes unless power actuators are specified.

The standard operating temperature range for Saf-T-Seal valves is −20°F (−30°C) to 250°F (120°C). On special order, valves can be supplied for temperatures as low as −75°F (−60°C).

300-lb. class, handwheel operated, 2" through 12"

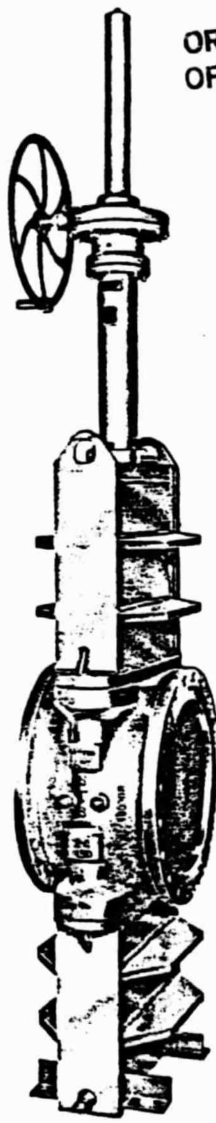
400, 600, 900, 1500-lb. classes, handwheel operated, 2" through 4"



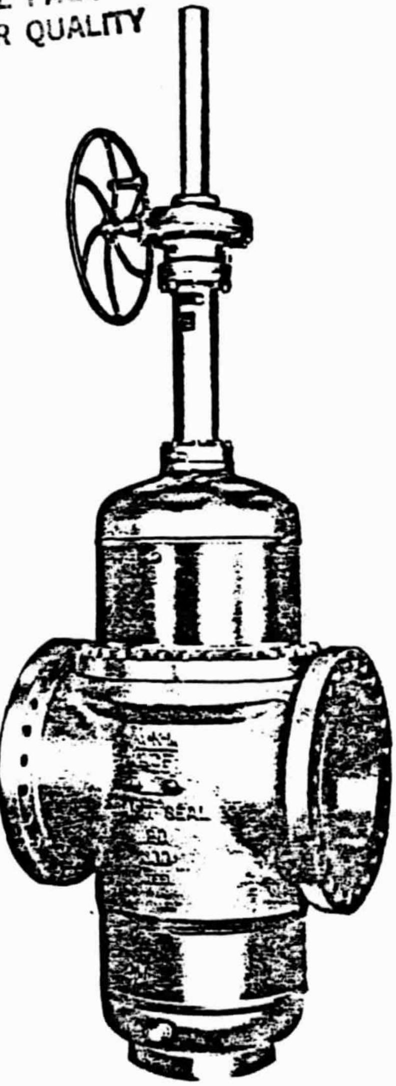


400-, 600- & 900-lb. classes, bevel gear operated, 6" through 12"

400-, 600- & 900-lb. classes, handwheel operated, 6" through 12"



150-lb. class, bevel gear operated, 14" through 36"



300-, 400-, 600- & 900-lb. classes, bevel gear operated, 14" through 36"

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COUNTY RD. 92 AND NIKE RD., P.O. BOX 284
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NORMAN HOFFMAN

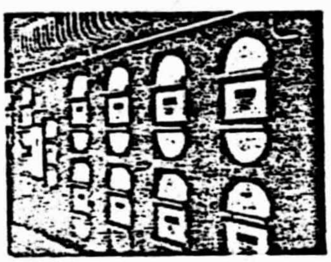
PHONE (612) 446-1511



## EXPLOSION DOORS
(see Doors: Fire, Fireproof)

## EXPLOSIVE DEVICES
(see Pyrotechnic Devices)

# EXPLOSION DOORS



- Strong lightweight hinged honeycomb panels with pressure operated magnetic latches
- For explosion venting or access
- Supplied with frames for welding or bolting to housings
- Standard designs to 10 ft.², 27" W.G. operating range, 300°F. Factory tested repeatable to + 3" W.G.
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a product or service
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Apache Powder Co. P.O. Box 700 (Industrial, Dynamite, Blasting Agents) ........ 10M+
*ARIZ: TEMPE*
Access Control Systems 2105-T S. Hardy Dr. .. 1/2M+
*CAL: FAIRFIELD*
Explosive Technology P.O. Box KK ........ 1M+
*CAL: HOLLISTER*
Holex Inc. 2751-T San Juan Rd. (Electro) ........ 1M+
Teledyne McCormick Selph 3601 Union Rd., P.O. Box 6 ........ 1M+
*CAL: NEWHALL*
Special Devices, Inc. 16830 W. Placerita Canyon Rd. (Propellant & Explosively Activated Components & Systems) ........ 5M+
*CAL: POMONA*
Broco Inc. 2040 N. Towne Ave., P.O. Box 1768-T (Hazardous Materials Disposal) ........ 1M+
*CAL: SAUGAS*
Whittaker Corp., Bermite Div. 22116 W. Soledad Canyon Rd. ........ 50M+
*CAL: STOCKTON*

*MINN: BROOKLYN CENTER*
MEDTRONIC, INC. ENERGY TECHNOLOGY ... Shingle Creek Pkwy. (ZIP ... 3968) ........
*MINN: MINNEAPOLIS*
Tekna-Seal, Inc. 7308-R Aspen Lane ... Ceramic To Metal, Hermetic Seals ...
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Battelle & Renwick, Inc. P.O. Box 7162 ...
*NJ: FLANDERS*
TSI CORPORATION P.O. Box 206-T (ZIP ... (Forestry, Engineering & Environmental ... Supplies, Etc.) (201—584-3417) ........
See our catalog in THOMCAT ...
*NJ: FLEMINGTON*
Atomized Metal Powders Inc Box 21? ... Brushes, Friction Materials, Powdered ... Parts) ........
*NJ: LAKEHURST*
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Mackhard Incorporated 136-A S. ... Handler/Mini Robotics) ........
*NY: SCHENECTADY*
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*OHIO: BELLAIRE*
Ohio Fireworks Mfg. & Display Co ...
*OHIO: CLEVELAND*
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FLUIDYNE
ENGINEERING CORPORATION
5900 Olson Memorial Highway
Minneapolis, Minnesota 55422

IN REPLY REFER TO

24 June 1983

1380

Stresau Laboratory, Inc.
Star Route, Box 189
Spooner, Wisconsin 54801

Attention: Mr. Jim Graber

Dear Mr. Graber:

The enclosed sketch shows the quick opening valve concept we discussed by phone last week. The gas reservoir/piston arrangement is intended to provide the force to accomplish the valve travel of 18 inches in approximately 0.03 to 0.05 seconds. An average pressure of 650 psi in the reservoir would be required.

Please give us your throughts as to how a pyrotechnic could be used in this application to quickly generate the needed gas pressure. The number of runs/day is estimated at 4 to 8.

I would like to get your reaction to this proposal application by 1 July 1983. Please call if you have any questions.

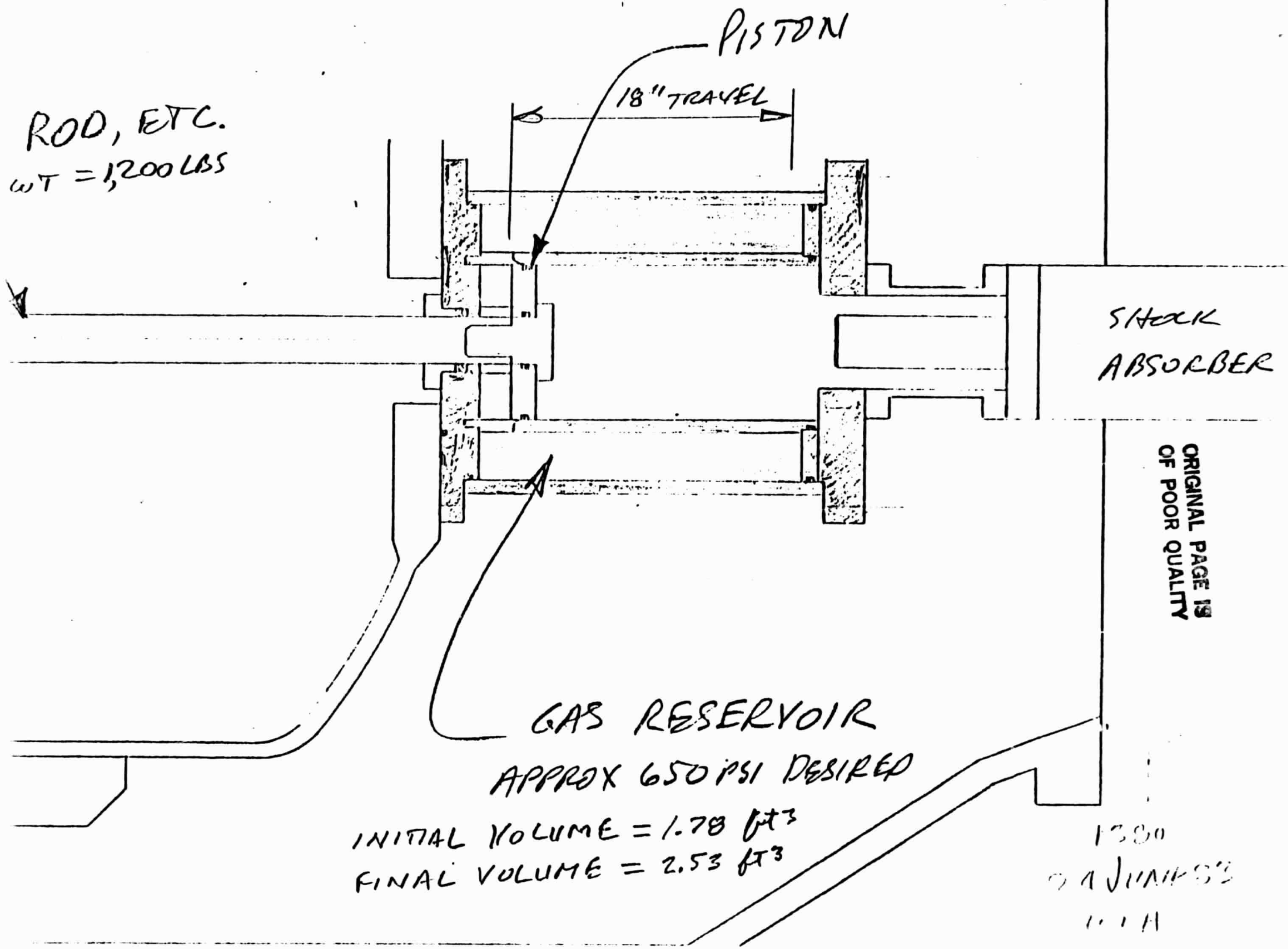
Very truly yours,
FLUIDYNE ENGINEERING CORPORATION

W. B. Hamre

William B. Hamre

WBH/sjl

Enc.


PISTON
18" TRAVEL
ROD, ETC.
WT = 1,200 LBS
SHOCK ABSORBER
GAS RESERVOIR
APPROX 650 PSI DESIRED
INITIAL VOLUME = 1.78 $ft^3$
FINAL VOLUME = 2.53 $ft^3$

**LUKENS STEEL**

Lukens Steel Company
Coatesville, PA 19320

JUL - 5 1983
FLUIDYNE ENG. CO.

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## PROPOSAL

DATE • 06/28/83
YOUR INQUIRY •
OUR QUOTATION • CH-3933
• PAGE 1 OF 1 PAGES

Fluidyne Engineering Corporation
5900 Olson Memorial Highway
Minneapolis, Minnesota 55442

Attention: Mr. Bill Hamre

| | | | | | |
|---|---|---|---|---|---|
| Item No. | | 1 | | | |
| Quantity | | 1 | | | |
| Dwg. Number | | | | | |
| Style | | Elliptical Head | | | |
| Diameter | Outside | 54" | | | |
| | Inside | | | | |
| Gauge | Min | 1" | | | |
| | Nom | | | | |
| Radius of Dish | | | | | |
| Straight Flange | | 2" | | | |
| Inside Corner Radius | | | | | |
| Overall Height | | | | | |
| Machining Style | | Style A (SQUARE) | | | |
| Heat Treatment | | | | | |
| Fluing | | | | | |
| Material | Quality | ASTM-A516, Grade 70 | | | |
| | Spec | | | | |
| Est. Shipping Weight Each | | 1,176 Pounds Each | | | |

Prices

Price Each: $1,226.00 Each

Price includes metal, forming, and machining.

Die or Tooling Charge:

PRICES ARE F.O.B. MILL, COATESVILLE, PENNSYLVANIA.

Shipment

Shipment After Receipt of Order at Coatesville: 4 to 5 Weeks

REMARKS: We appreciate this opportunity to quote and trust we can be of service to you in the future.

Very truly yours,
LUKENS STEEL COMPANY
1100 Jorie Boulevard, Suite 224
Oak Brook, Illinois 60521
Robert W. Insetta
Resident Sales Manager, Milwaukee

Per: Judi Nieman
Judi Nieman

JJN: cak

SEE REVERSE SIDE FOR TERMS AND CONDITIONS OF SALE

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ACE controls inc.

23435 INDUSTRIAL PARK DRIVE • FARMINGTON, MICH. 48024 • (313) 476-0213 • TELEX 235614


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JUL - 5 19..
FLUIDYNE ENG. CO.

ACE CONTROLS INC. 20th Anniversary 1963-1983

July 1, 1983

Mr. Bill Hamre
FLUIDYNE ENGINEERING CORPORATION
5900 Olson Highway
Minneapolis, MN 55422

Dear Mr. Hamre:

As per our telephone conversation today regarding a shock absorber application (your quotation for NASA), I suggest using one SHS 4 x 8 R ACE shock absorber. This is a self-contained, spring return, four inch bore, eight inch stroke, rear flange, custom orificed shock absorber. The design parameters are:

| | | |
|---|---|---|
| Weight | = | 1200 Pounds |
| Velocity | = | 60 Feet Per Second |
| Propelling Force | = | None |
| Cycle Rate | = | 1 Per Hour, 5 Per Day |
| Environment | = | Clean Dry Air |

The cost of the SHS 4 x 8 R will not exceed 2000 dollars. If you require further information feel free to contact me.

Yours very truly,

ACE CONTROLS, INC.

Robert Goodman

Robert Goodman
Applications Engineer

RG/mw

cc: J. E. Braas
G. Richardson

# APPENDIX D

# CALCULATIONS

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

HOLE GEOMETERY

CALCULATION PACKAGE NO. 1

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB: MSFC VALVE CODE: 1380 SHT NO: 1 OF 3 PKG: 1

COMPONENT: PERFORATED SLEEVE REF: BY: WRH DATE: 13 MAY 82

SUBJECT: HOLE GEO. CK BY: DATE:

RV BY: DATE:



(NEED ~ 11 $ft^2$ EFFECTIVE AREA)

SLEEVE HOLE PATTERN:

3" DIA HOLES

3½" SPACING AXIALLY

CIRCUMFERENCE = $\pi \times 50 = 157$"

SPACE CIRCUMFERENTIALLY @ 8°

OR $\frac{8}{360} \times \pi \times 50 = 3.49$"

USE 22 HOLES PER ROW, OR

$\frac{\pi \times 50}{22} = 7.14$" SPACING

FIND LENGTH OF SLEEVE REQ'D

FOR 16.8 $FT^2$ OPEN AREA:

$\frac{22 \times 7.07}{144} = 1.08\ ft^2/row$

FOR 16.8 $FT^2$ TOTAL (JLG)

USE 16 ROWS OR 15 SPACES

$\frac{16 \times 3.5}{12} = 4.67$ LONG.

SAY 5 FT LONG.

$\ldots .08 = 17.3\ FT^2 > 16.8$

$16 \times 22 = \underline{352}$ HOLES

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 3 PKG 1

BY WDH DATE 13 MAY 82

COMPONENT ______ REF ______

CK BY ______ DATE ______

SUBJECT SLEEVE - HOLE GEOMETRY RV BY ______ DATE ______

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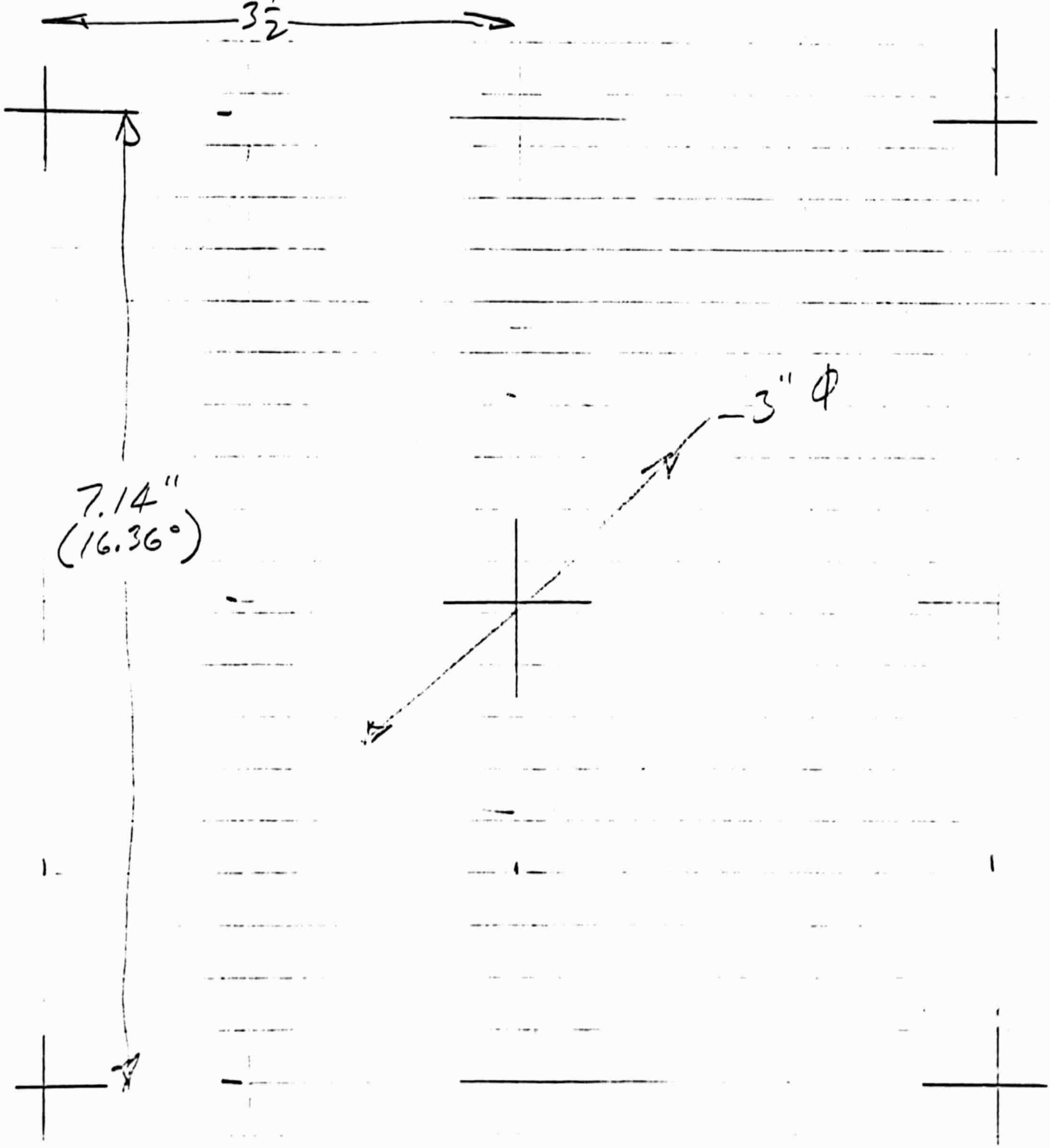

JOB MSFC VALVE CODE 1380 SHT NO 3 OF 3 PKG 1

BY WCH DATE 13 MAY 83

COMPONENT SLEEVE REF

CK BY DATE

SUBJECT HOLE GEO. RV BY DATE

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ASSUMING 4" DIA HOLES

USE 16 HOLES / ROW (CIRCUMFERENTIAL)
9.8" SPACING

$$\frac{16 \times 12.56}{144} = 1.4 \ FT^2/ROW$$

$$\frac{16.8}{1.4} \cong 12 \ ROWS \quad (11 \ SPACES)$$

LENGTH @ $4\frac{1}{2}$" SPACING

$$\frac{11 \times 4.5}{12} = 4\tfrac{1}{3} \ FT \sim 5 \ FT$$

TOTAL HOLES = 12 x 16

= 192 HOLES

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

SLEEVE THICKNESS

CALCULATION PACKAGE NO. 2

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 1 PKG 2
BY [illegible] DATE 11 MAR [illegible]
COMPONENT PERF. SLEEVE REF ______ CK BY ______ DATE ______
SUBJECT SLEEVE TKNS RV BY ______ DATE ______

FIND APPROX THICKNESS OF SLEEVES:
(ASSUME SAME HOLE PATTERN AS 4×4)

OUTER SLEEVE:

ASSUME FULL PRESSURE TO FULL AREA
ASSUME STRESS CONCENTRATION FACTOR = 4.5
ASSUME 50.5" I.D. & 2" THICKNESS

$$f_t = \frac{PD}{2t} = \frac{650 \times 50.5}{2 \times 2} \times 4.5$$

$$= 37{,}000 \text{ PSI}$$

USE 410 S.S. WITH $F_y = 100{,}000$ PSI

$$F.S. = \frac{100{,}000}{37{,}000} = 2.7 \quad O.K.$$

(SIMILAR TO ROC)

— CONSERVATIVE —

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

ACTUATOR REQUIREMENTS

CALCULATION PACKAGE NO. 3

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

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JOB MSFC VALVE CODE 1380 SHT NO 1 OF 5 PKG 3

COMPONENT PERF. SLEEVE BY WCH DATE 11 MAY 83

REF

SUBJECT APPROX ACTUATOR REQMTS CK BY DATE

RV BY DATE

ROTATIONAL MOTION ⇒ OUTER SLEEVE

FIRST FIND MOMENT OF INERTIA

ASSUME: 60% SOLID
2" THICK
68" LONG
} OUTER SLEEVE

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SLEEVE

$WT = \pi \times 52.5 \times 2 \times 68 \times .6 \times .283 = 3800 \text{ LBS}$

$$I = \frac{W}{g} r^2 = \frac{3800}{32.2} \left(\frac{52.5}{2 \times 12}\right)^2$$

$$= 566 \text{ LB FT SEC}^2$$

ACTUATOR ROD & CRANK ARM

ASSUME ½ × I OF SLEEVE

$\therefore$ TOTAL $I = 1.5 \times 566$

$$= 850 \text{ LB. FT. SEC}^2$$

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 3 PKG 3

COMPONENT PERF. SLEEVE BY MCH DATE 12 MAY

REF

SUBJECT ACT. RQMTS - ROT. OUTER SLEEVE CK BY ____ DATE ____

RV BY ____ DATE ____

LOOK AT ACTUATOR REQ'MTS: (ROTATIONAL)

ASSUME: I OF SYSTEM = 850 LB FT SEC$^2$

ROTATION OF SLEEVE = 20° OR .35 RAD

RADIUS OF ARM = 38"

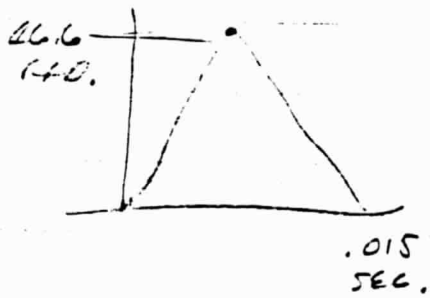
ACTUATION TIME = 0.015 SEC.

AVG. VEL. $= \frac{.35}{.015} = 23.3$ RAD/SEC

DOUBLE FOR MAX VELOCITY = 46.6 RAD/SEC.

$\alpha = \frac{\omega}{t} = \frac{46.6}{.0075}$

$= 6,210$ RAD/SEC$^2$




TORQUE $= I\alpha$

$= 850 \times 6210$

$= 5.3 \times 10^6$ FT LBS

FORCE ON 38" ARM

$= \frac{5,300,000 \times 12}{38}$

$= 1.7 \times 10^6$ LBS.

TOO HIGH!

JOB: MSFC VALVE  CODE: 1380  SHT NO 3 OF 5 PKG 3

BY: WBH  DATE: 12 MAY

COMPONENT: PERF. SLEEVE  REF:  CK BY:  DATE:

SUBJECT: AXIAL ACTUATION  RV BY:  DATE:

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ACTUATOR:

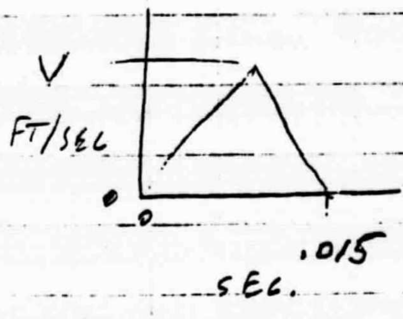
ASSUME 5" AXIAL MOVEMENT OF INNER SLEEVE TO OPEN, IN 0.015 SEC

WT @ $1\frac{1}{4}$" THICK, 47" DIA, 68" LONG & 37% POROUS:

$WT = \pi\ 47 \times 68 \times 1.25 \times .283 \times .63$

$= 2{,}240$ LBS

ASSUME VEL. PROFILE:




FOR 1/2 OF STROKE ($2\frac{1}{2}$"):

$S = V\,t$ (avg vel)

$\frac{2.5}{12} = V \times .0075$

$V = 28$ FT/SEC

MAX VEL = 2 × AVG VEL = 56 FT/SEC.

$Vel = a\,t$

$56 = a \times .0075$

[illegible]

FORCE = $m\,a$

$$F = \frac{2240}{322} \times 7500$$

$$= \underline{522{,}000 \text{ LBS}}$$

TOO HIGH!

$$a = \frac{2S}{T^2}$$

½ OF OPENING TIME

| S | T | a | F | |
|---|---|---|---|---|
| 2½" | .0075 | 8500 | $522^K$ | |
| 2½ | .015 | 1850 | $127^K$ | |
| 1¾ | .015 | 1300 | $90^K$ | 14" |
| 1¾ | .020 | 730 | $50^K$ | 10" |
| 1¾ | .0075 | 5200 | $360^K$ | 27" |

| | | | |
|---|---|---|---|
| JOB MSFC VALVE | CODE 1380 | SHT NO 5 OF 5 PKG 3 | |
| | | BY WBH | DATE 25MAY85 |
| COMPONENT PERFORATED SLEEVE | REF | CK BY | DATE |
| SUBJECT CHECK → AXIAL ACTUATOR | | RV BY | DATE |



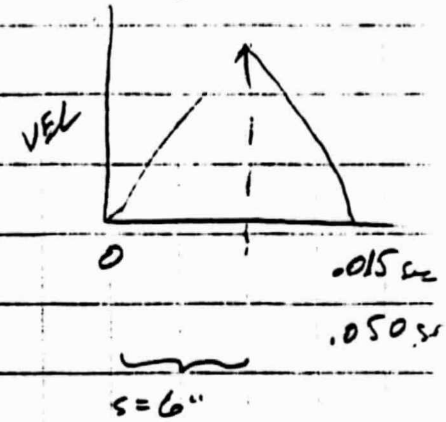
FIND ACTUATING FORCE:

DISTANCE = 6"

TIME = .0075 sec.

$$a = \frac{2S}{t^2} = \frac{2 \times 6}{.0075^2} \times \frac{1}{12}$$

$18{,}000\ ft/sec^2$




$$F = Ma = \frac{500}{32.2} \times 18{,}000$$

$= 280{,}000$ LBS

FOR TIME = .025 sec. (.05 TOTAL)

$$a = \frac{2 \times 6}{.025^2 \times 12} = 1600\ FT/sec^2$$

$$F = \frac{500}{32.2} \times 1600 = 25{,}000\ LBS$$

REASONABLE

CONCLUSION: AXIAL ACTUATION OF LIGHTER INNER SLEEVE IS PREFERRED OVER ROTATION OF OUTER SLEEVE. ACTUATOR

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

AXIAL ACTUATOR, OPEN - CLOSE

CALCULATION PACKAGE NO. 4

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 2 PKG 4

BY WBH DATE 17MAY83

COMPONENT SLEEVE VALVE REF

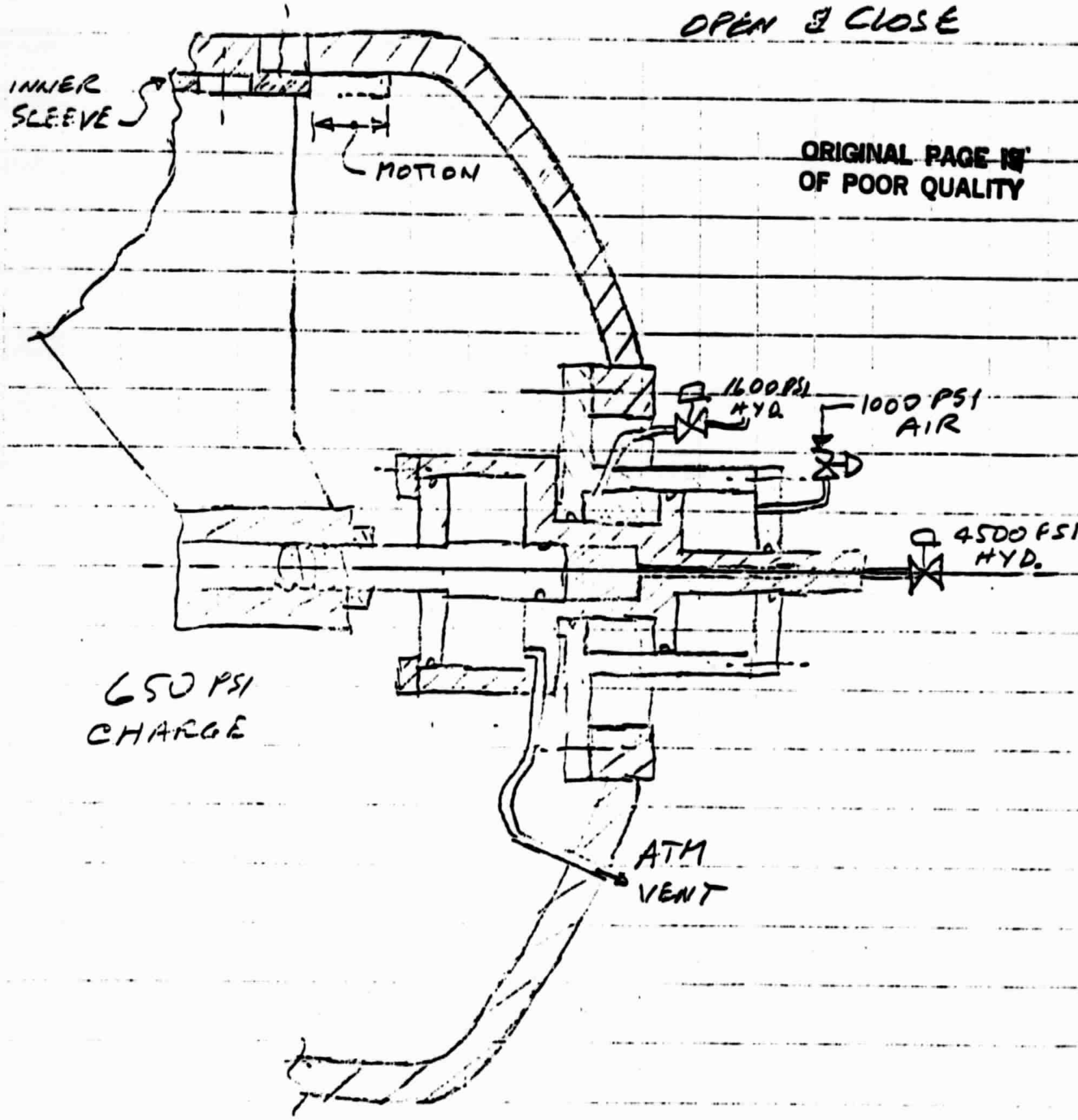
CK BY ____ DATE ____

SUBJECT ACTUATOR ~50K

RV BY ____ DATE ____

AXIAL MOTION:
OPEN & CLOSE





10" DIA 78.5
3" DIA − 7.1
71.4 × 650 = 46.4^K

3 5/8" DIA 10.3 × 4,500 = 46.4^K

8" DIA 50.3
2" DIA 3.1
47.2 × 1000 = 47.2^K

8" DIA 50.3
5" DIA − 19.6
30.7 × 1600 = 49.1^K

NOTE:
1. 650 PSI CHARGE PRESSURE IS NOT ALWAYS AVAILABLE
2. QUICK CLOSE IS NOT REQ'D

**FLUIDYNE ENGINEERING CORPORATION**

# QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

## BUTTERFLY VALVE

## CALCULATION PACKAGE NO. 5

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 12 PKG 5
BY WCH DATE 10 MAY 83
COMPONENT SHUT-OFF VALVE REF
CK BY DATE
SUBJECT RV BY WCH DATE 23 MAY 83

THE BUTTERFLY VALVE APPEARS TO BE THE LEAST COSTLY OF THE TIGHT SHUT-OFF VALVES (USED IN SERIES WITH THE QUICK OPENING SLEEVE VALVE.

SINCE VALVE MANUFACTURERS HAVE NOT RESPONDED TO INQUIRIES FOR THIS SIZE (48") & PRESSURE (650psi), A VERY LIMITED CONCEPTUAL DESIGN EFFORT WILL BE UNDERTAKEN



23 MAY NOTE: AS A RESULT OF THE MEETING @ MSFC ON 19 MAY, THE TWO VALVE APPROACH WAS DROPPED

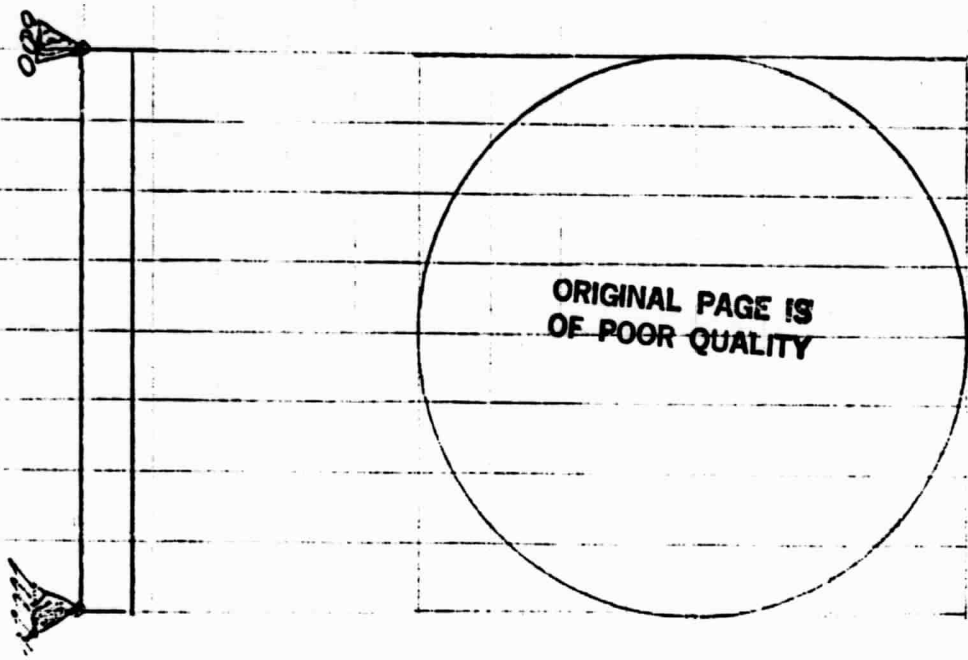
JOB MSFC VALVE CODE 1380 SHT NO 2 OF 10 PKG 5

COMPONENT BUTTERFLY VALVE REF ___ BY WBH DATE 10 MAY 75

SUBJECT 1ST CUT. STRUCTURAL ANAL. CK BY ___ DATE ___

RV BY ___ DATE ___

CONSIDER BUTTERFLY VALVE, STRUCT. REQ'D




LOAD = 650 PSI

1" WIDE STRIP, 48" LONG.

$$f_b = \frac{M}{S} = \frac{wl^2}{8S} = \frac{wl^2 \times 6}{8bd^2}$$

$$d = \sqrt{\frac{wl^2 \times 6}{f_b\, 8b}}$$

$f_b = 20{,}000$ psi

$l = 48$ IN

$b = 1$ IN

$w = 650$ psi

$d = 7\tfrac{1}{2}$"

ASSUME 10" THICK @ CENTER

JOB MSFC VALVE CODE 1380 SHT NO 3 OF 10 PKG 5
BY WBH DATE 10 MAY 8_

COMPONENT ________ REF ________ CK BY ________ DATE ________

SUBJECT ________ RV BY ________ DATE ________

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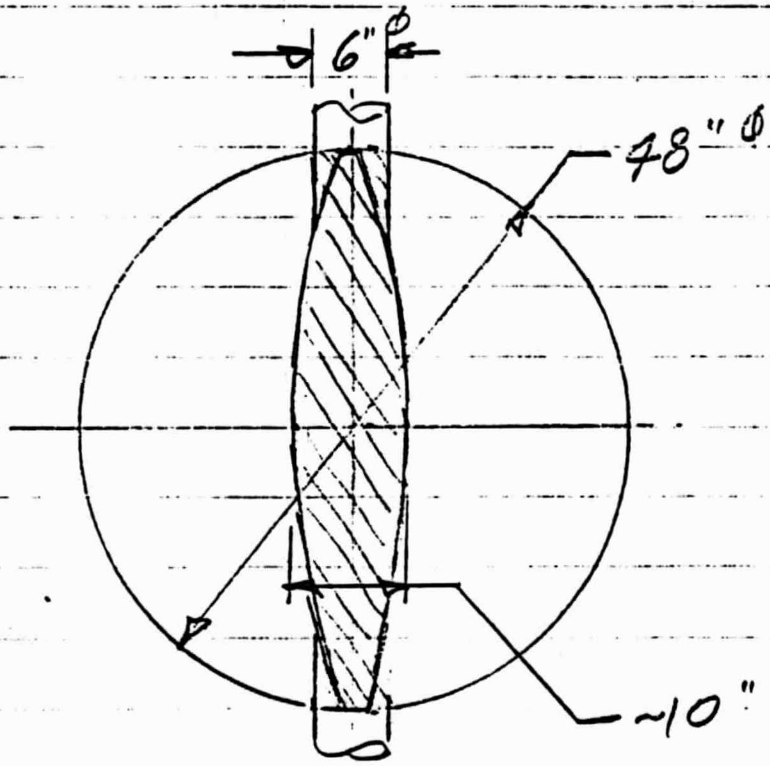
ASSUME 6"$\phi$ STEMS ; FIND $S_s$

$$S_s = \frac{P}{A} = \frac{1,302,000}{2 \times 28.3} = 23,000 \text{ PSI}$$

HIGH

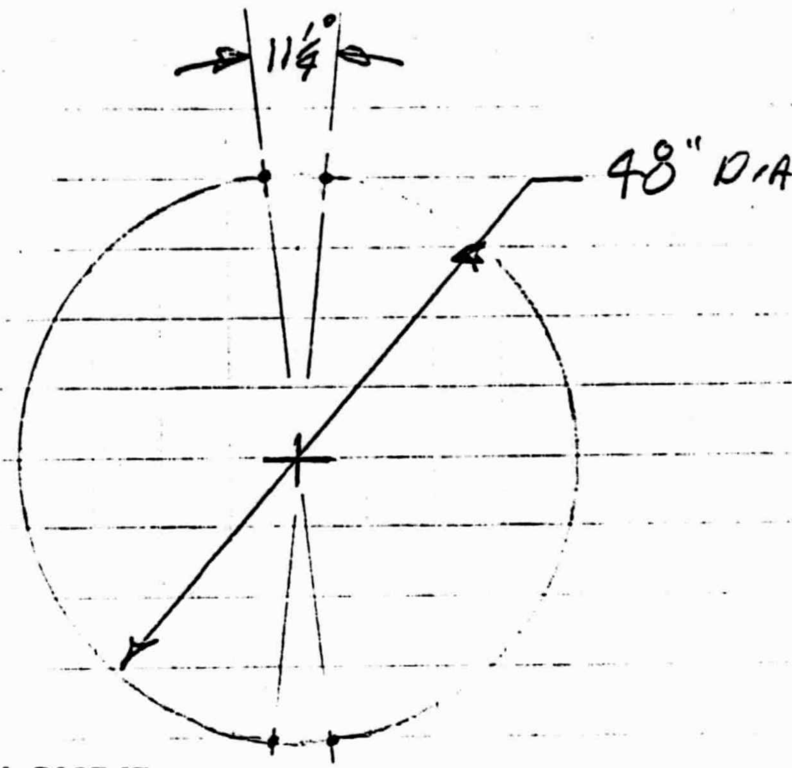
BLOCKAGE EQUIVALENT TO ~9" WIDE STK

$$\% = \frac{9 \times 48}{12.56 \times 144} \times 100 = 24\%$$



JOB MSFC VALVE CODE 1380 SHT NO 4 OF 10 PKG 5
BY WBH DATE 16 MAR '83
COMPONENT BUTTERFLY VALVE REF ____ CK BY ____ DATE ____
SUBJECT COMPUTER ANALYSIS RV BY ____ DATE ____

- DISC, 48" DIA
- UNIFORM THICKNESS
- 2-SIMPLE SUPPORTS EACH SIDE
- 650 PSI PRESS LOAD
- STEEL, $E = 29 \times 10^6$
- CALC. STRESS & DEFL. FOR THICKNESS OF:
  6"
  8"
  10"






USE MODEL SIMILAR TO HONEYCOMB MODEL ON JOB 1377.

JOB MSFC VALVE CODE 1380 SHT NO 5 OF 10 PKG 5
BY WBH DATE 18 MAY 8?
COMPONENT B. F. VALVE REF ___ CK BY ___ DATE ___
SUBJECT ANALYSIS RESULTS - COMPUTER RV BY ___ DATE ___

RESULTS OF COSMOS ANALYSIS OF BUTTERFLY DISC:

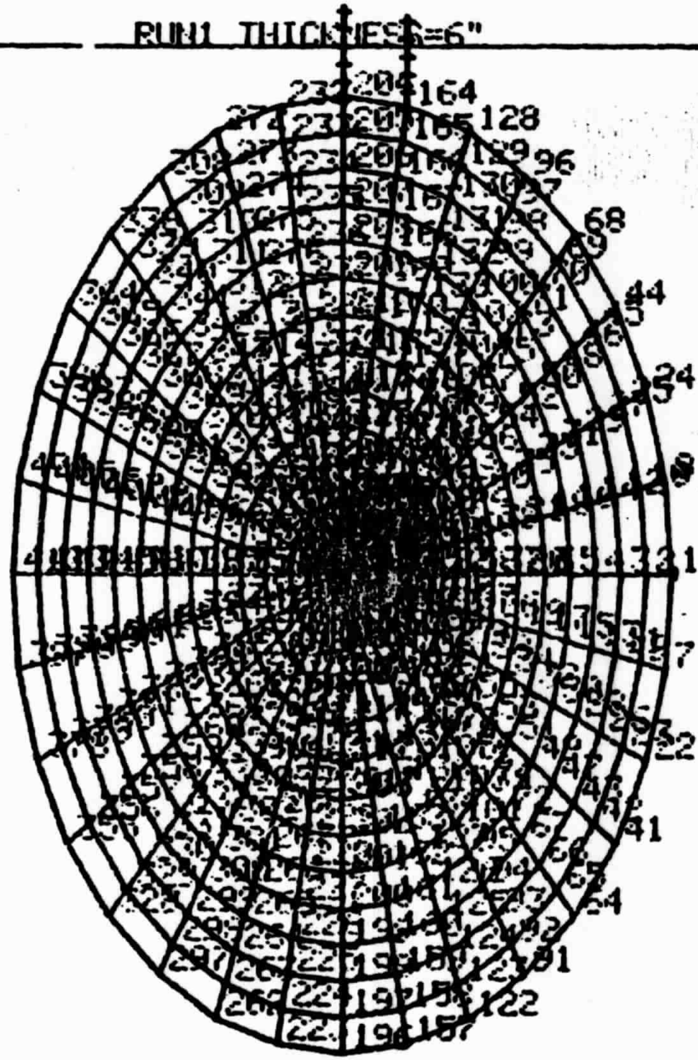


GENERAL

- THE DISC IS MODELED AS CONSTANT THICKNESS, ACTUAL WOULD BE TAPERED
- THICKNESS TO DIAMETER RATIO IS LARGE - PLATE ELEMENT ANALYSIS IS FOR THIN PLATES; ERROR MAY BE ~20%
- SOME QUESTION RE ZERO X AND Y MOVEMENT OF EDGES.

| RESULTS | | 6" THICK | 9" THICK |
|---|---|---|---|
| DEFL @ CENTER | ($t^3$) | .098" | .029" |
| DEFL @ SIDE EDGE | ($t^3$) | .136" | .040" |
| ROTATION @ TOP EDGE | ($t^3$) | .43° | .13° |
| MAX STRESS | ($t^2$) | 42,000 PSI | 19,000 P[illegible] |

RUN1 THICKNESS=6"



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| | |
|---|---|
| PLOT LIMITS | |
| X | -2.405E+01<br>2.405E+01 |
| Y | -2.405E+01<br>2.405E+01 |
| Z | 0.000E+00<br>0.000E+00 |
| DATE 17-MAY-83 | |
| TIME 11:05:11 | |
| POST/COSMOS S.R.A.C. | |
| VIEW DIR.: 0 0 1 | |
| VIEWING DIST 1.000E+20 | |
| ROTATION AXES: Y 4.500E+01 | |

Y X Z

6/10 PKJ:5

RUN1 THICKNESS=6"

LOAD CASE , MODE SHAPE 1



DEFORMED SCALE
5.000E+01

PLOT LIMITS

| | |
|---|---|
| X | -2.405E+01 |
| | 2.405E+01 |
| Y | -2.405E+01 |
| | 2.405E+01 |
| Z | 0.000E+00 |
| | 0.000E+00 |

DATE
17-MAY-83

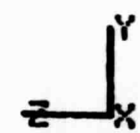
TIME
10:25:03

POST/COSMOS
S.R.A.C.

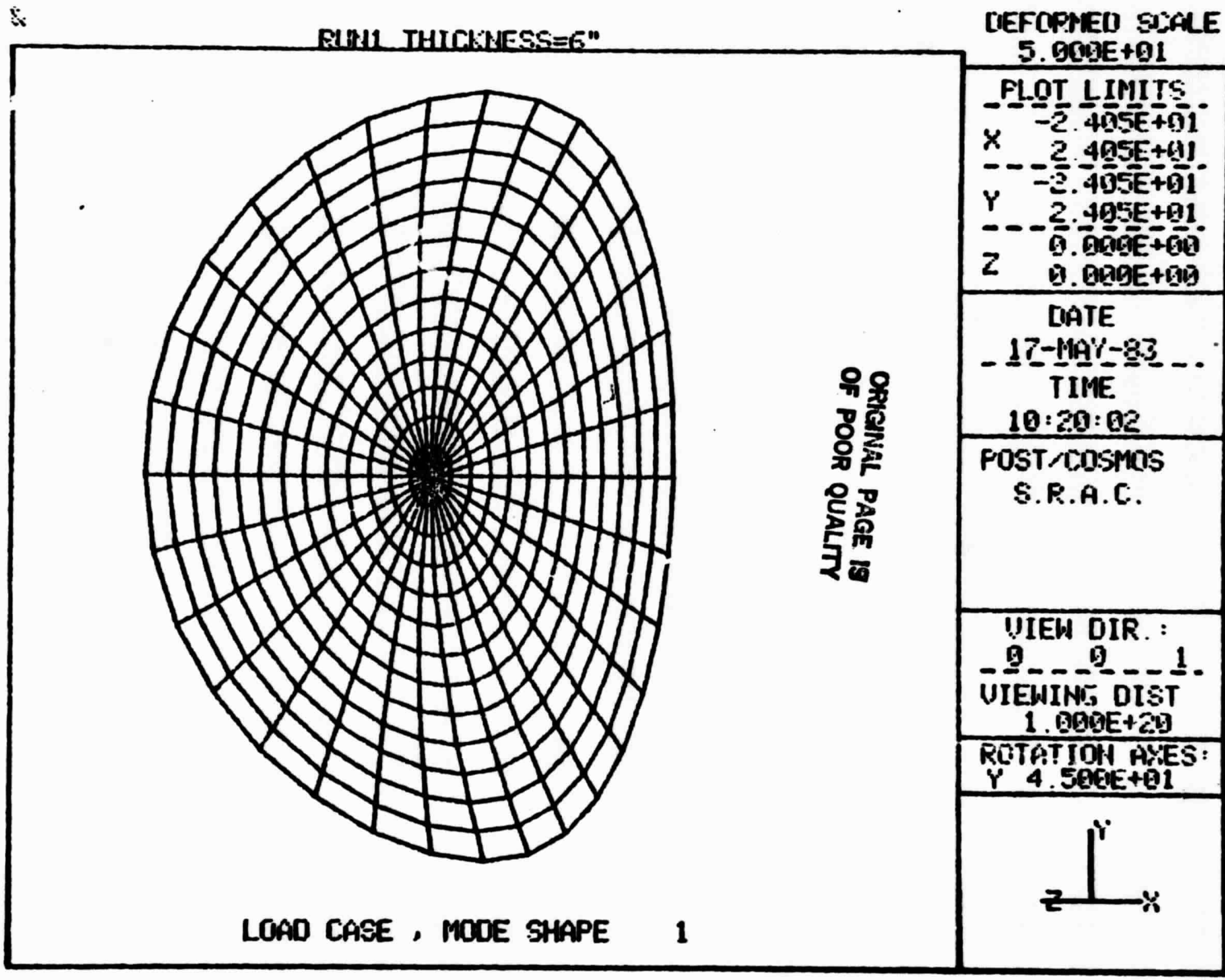
VIEW DIR.:
0 0 1

VIEWING DIST
1.000E+20

ROTATION AXES:
Y 9.000E+01



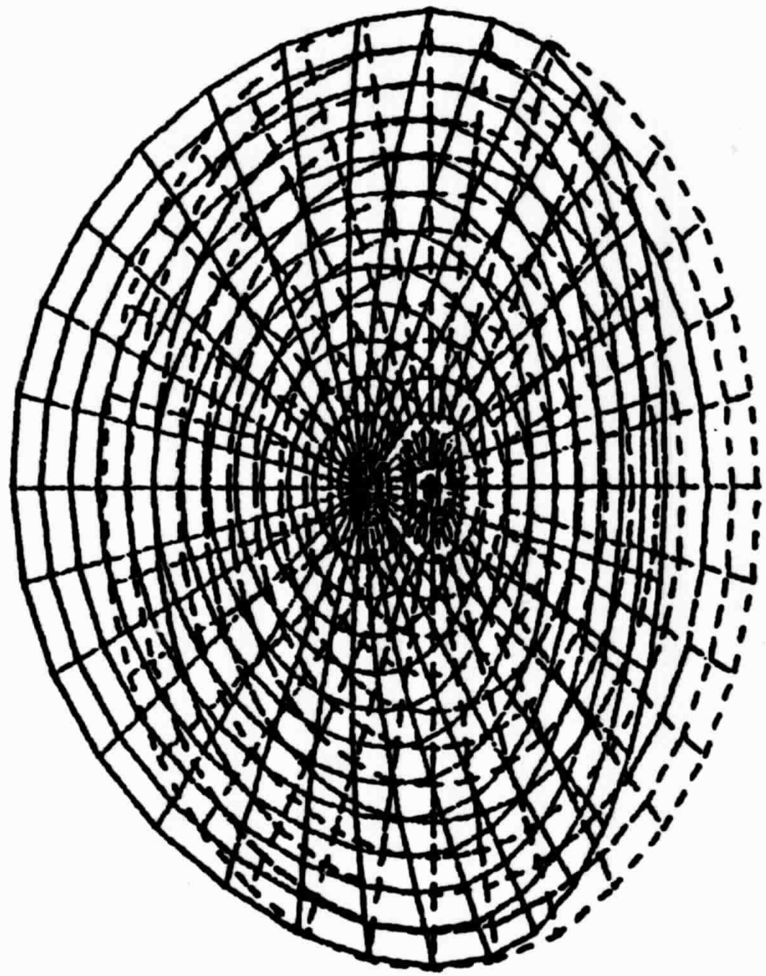

7/10 P.35


RUN1 THICKNESS=6"
DEFORMED SCALE
5.000E+01
PLOT LIMITS
X -2.405E+01
2.405E+01
Y -2.405E+01
2.405E+01
Z 0.000E+00
0.000E+00
DATE
17-MAY-83
TIME
10:20:02
POST/COSMOS
S.R.A.C.
VIEW DIR.:
0 0 1
VIEWING DIST
1.000E+20
ROTATION AXES:
Y 4.500E+01
Y
Z
X
LOAD CASE , MODE SHAPE 1



8/10 PMS

RUN1 THICKNESS=6"



LOAD CASE , MODE SHAPE 1



DEFORMED SCALE
5.000E+01

PLOT LIMITS

| | |
|---|---|
| X | -2.405E+01 |
| | 2.405E+01 |
| Y | -2.405E+01 |
| | 2.405E+01 |
| Z | 0.000E+00 |
| | 0.000E+00 |

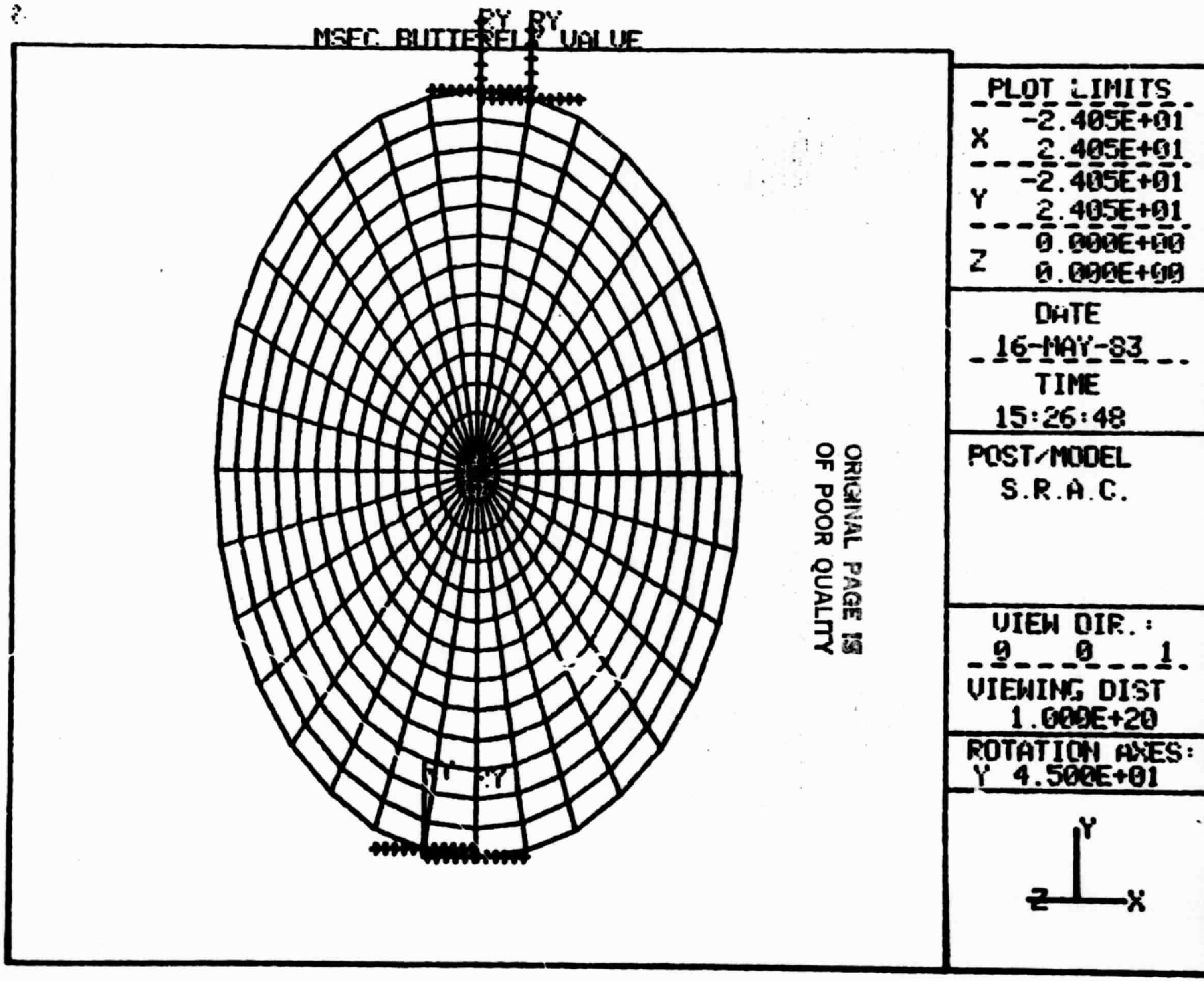
DATE
17-MAY-83
TIME
10:17.47

POST/COSMOS
S.R.A.C.

VIEW DIR.:
0 0 1
VIEWING DIST
1.000E+20

ROTATION AXES:
Y 4.500E+01


9/10 PKLE

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10/10 PKGS

# QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

## CONICAL PERFORATED SLEEVE

## CALCULATION PACKAGE NO. 6

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC QUICK OPENING VALVE CODE 1380 SHT NO. 1 OF 4 PKG. 6

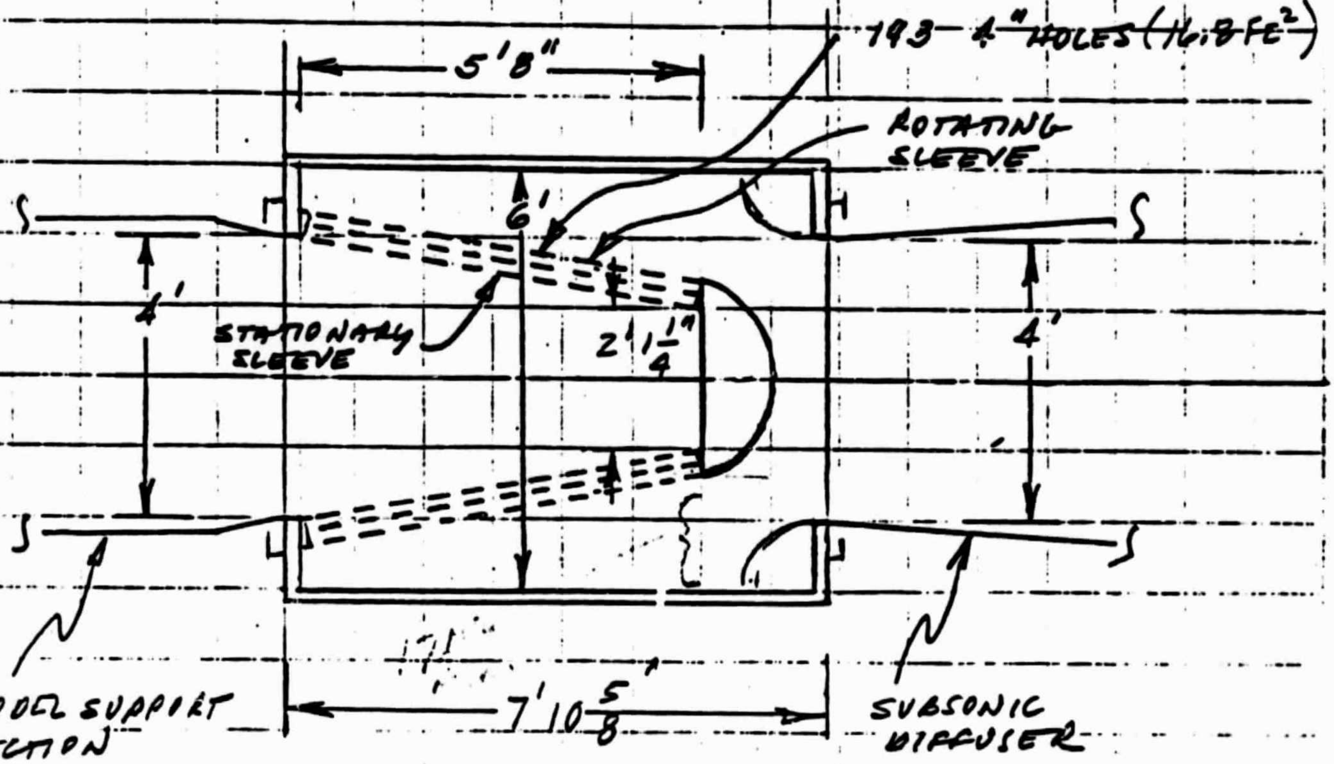
BY [illegible] DATE 5/5/83

COMPONENT CONICAL PERF. SLEEVE REF ______

CK BY ______ DATE ______

SUBJECT TAPERED SLEEVE VALVE LAYOUT RV BY ______ DATE ______






QUICK OPENING VALVE
REPLACES DIAPHRAGM
CUTTER AND SPACER SPOOL

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 4 PKG 6

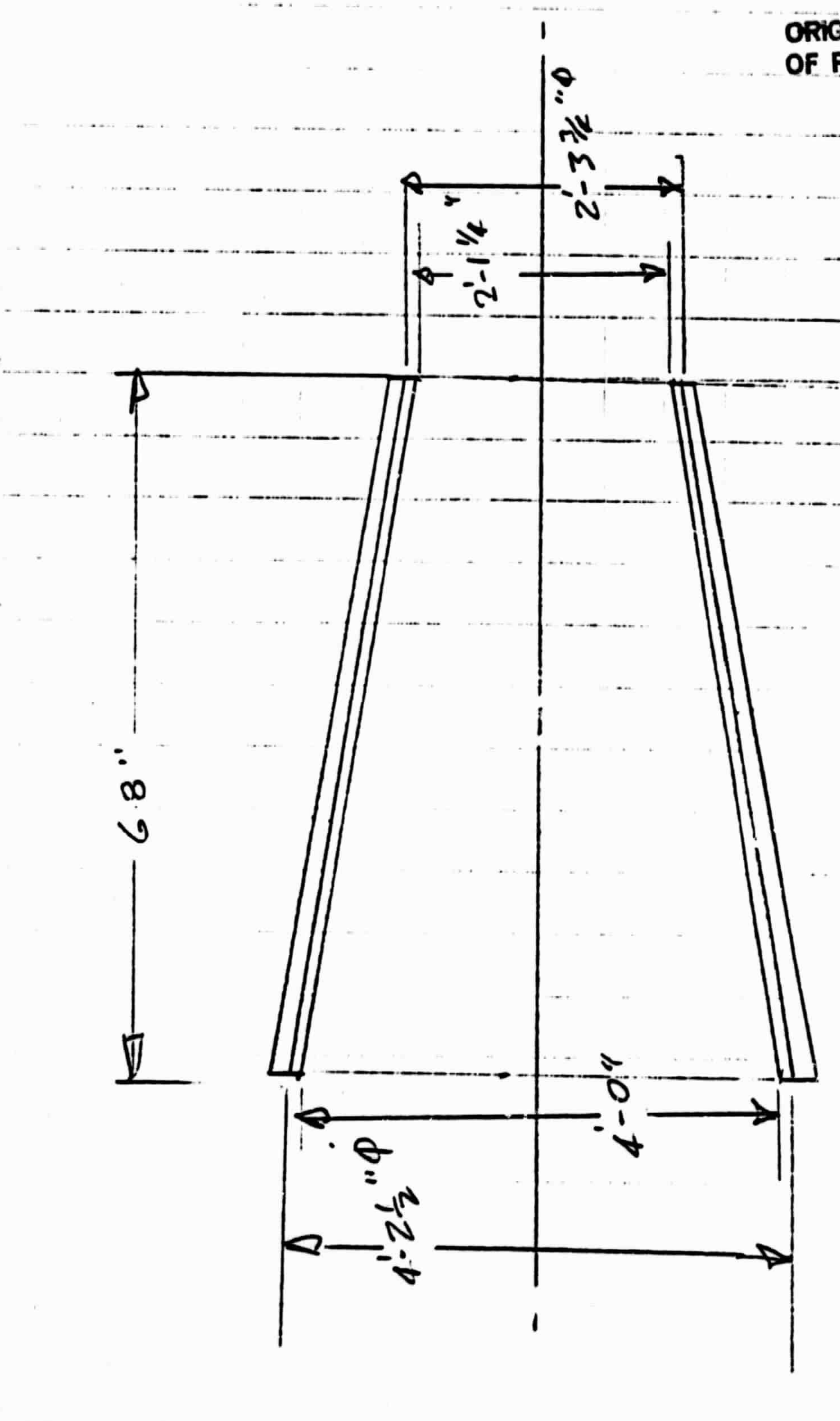
BY WBH DATE [illegible]

COMPONENT Conical PERF. SLEEVE REF

CK BY DATE

SUBJECT Geometry RV BY DATE






2'-3 7/16"Ø
A = 4.20 ft²

4'-2 1/2"Ø
A = 13.91 ft²

1. FIND END THRUST ON OUTER SLEEVE @ 650 PSIG:

$$T = 650 \times 144\ (13.91 - 4.20)$$
$$= 909{,}000 \text{ LBS}$$

THRUST ON 4'-2½" Ø (50½" Ø)

$$T = 650 \times 144 \times 13.91$$
$$= 1{,}302{,}000 \text{ LBS}$$

TOO LARGE!

2. FIND ANGLE OF SLEEVES FOR T ~ 50,000 LBS

$$\begin{array}{r} 1{,}302{,}000 \\ -\ \ 50{,}000 \\ \hline 1{,}252{,}000 \end{array}$$

$$F = \frac{\pi}{4} d^2 \times 650$$

$$\text{DIA} = \sqrt{\frac{F \times 4}{\pi \times 650}}$$

$$= 49.52 \text{ say } 49\tfrac{1}{2}''$$

$50\tfrac{1}{2} - 49\tfrac{1}{2} = 1''$ ON DIA.

$$\text{ANGLE} = \tan^{-1} \frac{.5}{68} = .42^\circ \text{ (HALF ANGLE)}.$$

FOR .020" CLEAR
AXIAL MOVEMENT
MUST BE ~ 3"

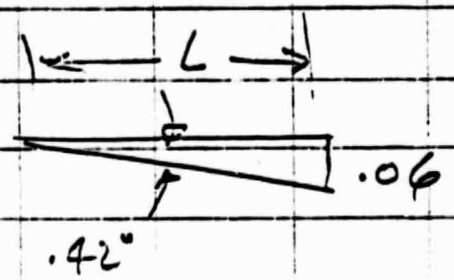
JOB MSFC VALVE CODE 1380 SHT NO. 4 OF 4 PKG 6

COMPONENT CONICAL PERF SLEEVE REF ______ BY WBH DATE 10MAY83

SUBJECT ______ CK BY ______ DATE ______

RV BY ______ DATE ______

3. ASSUMING CONE HALF ANGLE = .42°, FIND AXIAL MOVEMENT FOR 0.060 IN CLEARANCE BETWEEN SLEEVES:




$$\tan .42° = \frac{.060}{L}$$

$L = \underline{8.2}$ IN. TOO LARGE.

JOB 1380

# FLUIDYNE ENGINEERING CORPORATION

## QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

## SOLID VS PERFORATED SLEEVE

## CALCULATION PACKAGE NO. 7

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

| | | | |
|---|---|---|---|
| JOB MSFC T.T. VALVE | CODE 1380 | SHT NO 1 OF 1 | PKG 7 |
| COMPONENT SLEEVE VALVES | REF | BY WDH | DATE JUNE 9 |
| SUBJECT COMPARISON | | CK BY | DATE |
| | | RV BY | DATE |

+ = ADVANTAGE
− = DISADVANTAGE
0 = NEITHER ADV.

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| | SOLID SLEEVE | PERFORATED SLEEVE |
|---|---|---|
| SEALING | +1 | −3 |
| WEIGHT | +1 | −1 |
| TRAVEL DISTANCE | −1 | +1 |
| ACTUATOR FORCE | 0 | 0 |
| HOUSING LENGTH | 0 | 0 |

CONCLUSION:

SEALING IS THE OVERRIDING CONSIDERATION → USE THE SOLID SLEEVE.

NOTE: ALL FOLLOWING CALCULATIONS PERTAIN TO THE SOLID SLEEVE CONCEPT

**FLUIDYNE ENGINEERING CORPORATION**

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

FLOW AREAS

CALCULATION PACKAGE NO. 8

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

RADIAL FLOW AREA THRU RIBS:

$$A = \frac{\pi \times 54 \times 16 - 12 \times 1.625 \times 16}{144}$$

$$= \underline{16.7\ Ft^2}$$

ANNULAR FLOW AREA:

$$A = \frac{\pi \times (\overline{39}^2 - \overline{37}^2) - 12 \times 1\tfrac{5}{8} \times 4\tfrac{1}{2}}{144}$$

$$= \underline{16.6\ ft^2}$$

FLOW AREA ENTERING VALVE (8-1" SUPPORT PLTS)

$$A = \frac{\pi \times \overline{24}^2 - 8 \times 1 \times 20 - \pi\, 4^2}{144}$$

$$= \underline{11.1\ Ft^2}$$

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

OUTER HOUSING

CALCULATION PACKAGE NO. 9

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MFSC VALVE CODE 1380 SHT NO 1 OF 3 PKG 9
BY WCH DATE 16 JUNE
COMPONENT OUTER HOUSING REF
CK BY DATE
SUBJECT WALL THICKNESS RV BY DATE



ASSUME

78" I.D.

MATL = A 516 GR 70

ALLOW. STRESS = 17,500 PSI

DESIGN PER ASME SECTION VIII DIV 1

$$t = \frac{PR}{SE - 0.6P} \qquad E = 1.0$$

$$t = \frac{650 \times 39}{17{,}500 \times 1 - 0.6 \times 650}$$

$$= 1.48''$$

USE ~ 1 5/8"

25 JUNE: DESIGN PRESSURE IS 250 PSI

$$\therefore \quad t = \frac{250 \times 39}{17{,}500 \times 1 - 0.6 \times 250} = .56'' \text{ MIN.}$$

ADD ALLOWANCE FOR STRESS INCREASE AT CONE TO CYL JOINTS.

ASSUME 1" THICK.

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 3 PKG 7

COMPONENT OUTER HOUSING REF ____ BY WRH DATE 16 JUNE 93

SUBJECT WALL THKS. CK BY ____ DATE ____ RV BY ____ DATE ____



CHECK FOR LONGITUDONAL COMPRESSION STRESSES FROM DISCONNECT-TENSION ROD FORCE OF 500^K/ROD = 2,000^K TOTAL

$$S_c = \frac{P}{A} = \frac{2{,}000{,}000}{\pi \times 2 \times 39 \times 1}$$

$$= 8{,}200 \text{ PSI. O.K.}$$

CHECK FOR EMERGENCY CONDITION WHERE HOUSING IS PRESSURIZED TO 650 PSI (MAX TUBE CHARGE PRESS).

USING $S = F_{ty} = 38{,}000$ (A516 GR70)

$$t = \frac{PR}{SE - 0.6P}$$

$$= \frac{650 \times 39}{38{,}000 \times 1.0 - 0.6(650)}$$

$$= .674'' < 1.00$$

O.K.

JOB MSFC VALVE CODE 1380 SHT NO 3 OF 3 PKG 9

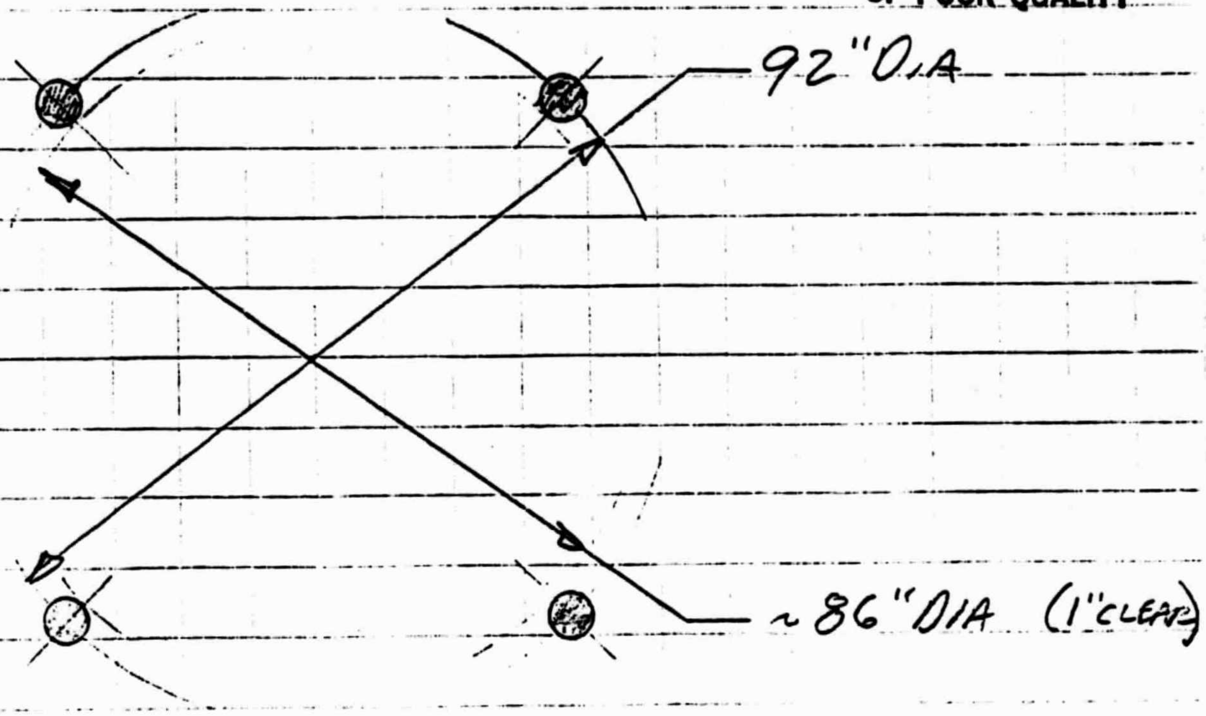
BY WBH DATE 11MAY8

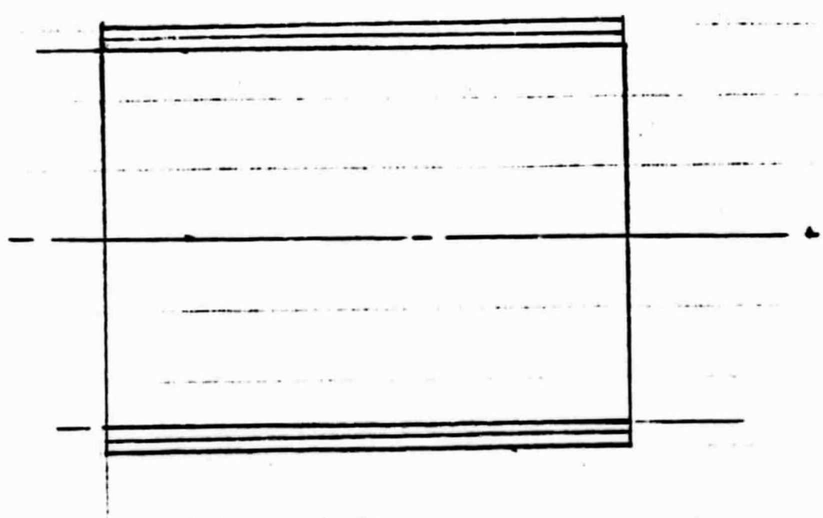
COMPONENT HOUSING REF ____ CK BY ____ DATE ____

SUBJECT CHECK MAX O.D. TO CLEAR RODS RV BY ____ DATE ____

DISCONNECT - TENSION RODS





FLUIDYNE ENGINEERING CORPORATION

# QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

## INNER HOUSING

## CALCULATION PACKAGE NO. 10

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 2 PKG 10

BY WBH DATE 24 JUNE 83

COMPONENT INNER HOUSING REF ______ CK BY ______ DATE ______

SUBJECT THICKNESSES. RV BY ______ DATE ______

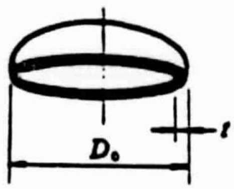
FIND REQ'D THICKNESSES : ORIGINAL PAGE IS OF POOR QUALITY

ASSUMING: A 516 GR 70 ; S = 17,500 PSI ; E = 1.0

$D_o = 54''$ ; $R_o = 27''$

$P = 650$

HEAD:




$$t = \frac{PD_o}{2SE + 1.8P}$$

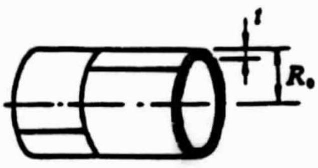
$$P = \frac{2SEt}{D_o - 1.8t}$$

2:1 ELLIPSOIDAL HEAD

$$t = \frac{650 \times 54}{2 \times 17{,}500 - 1.8 \times 650} = 1.038''$$

USE $1\frac{1}{8}''$

CYLINDER:




$$t = \frac{PR_o}{SE + 0.4P}$$

$$P = \frac{SEt}{R_o - 0.4t}$$

CYLINDRICAL SHELL Formulas for Longitudinal Seam

$$t = \frac{650 \times 27}{17{,}500 \times 1.0 + 0.4 \times 650} = .988$$

USE $1\frac{1}{16}''$

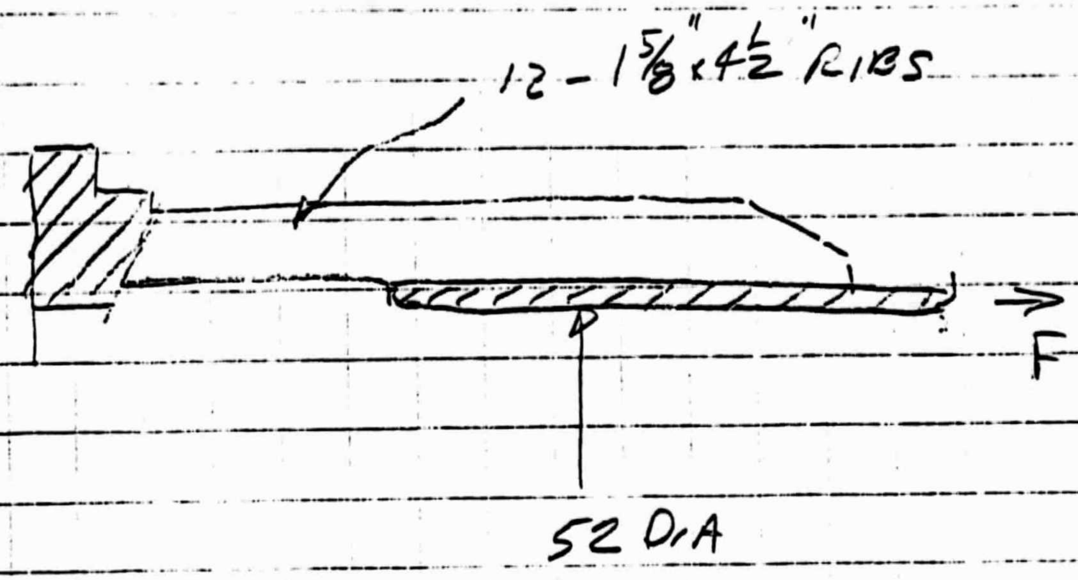
ENGINEERING CORPORATION

JOB MSFC VALVE CODE 1280 SHT NO 2 OF 2 PKG 10

BY WBH DATE 2 JUNE 8?

COMPONENT INNER HOUSING REF ______ CK BY ______ DATE ______

SUBJECT RIB THKNS RV BY ______ DATE ______




CHECK STRESS IN RIBS

TOTAL D. S. FORCE:

$$F = \frac{\pi}{4} \times \overline{52}^2 \times 650 = 1.38 \times 10^6 \text{ LBS}$$

$$\text{STRESS} = \frac{P}{A} = \frac{1.38 \times 10^6}{12 \times 1.625 \times 4.5} = 15{,}700 \text{ PSI}$$

ALLOW = 17,500 PSI

$\therefore$ O.K.

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FluiDyne ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

SLEEVE MECHANISM INCLUDING OPENING TIME

CALCULATION PACKAGE NO. 11

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| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 4 PKG 11
BY WBH DATE 1 June 84
COMPONENT SOLID SLEEVE REF
CK BY DATE
SUBJECT THICKNESS & WEIGHT RV BY DATE



1. THICKNESS REQ'D FOR SLEEVE:

$$\text{HOOP } t \cong \frac{P\ \text{DIA}}{2 \times S_t}$$

ASSUME T-1 (SA 517) MAT'L
WITH DIV 1 ALLOW = 28.3
DIV 2 ALLOW = 38.3

$$t = \frac{650 \times 48}{2 \times 28{,}300} = .551 \text{ say } 9/16''$$

2. WEIGHT EST.

$= \pi \times 48 \times 20 \times .562 \times .283$
$= 480$ LBS

RIBS ASSUME 4 @ 1" THICKNESS

$\text{WT} = 4 \times 21 \times 18 \times 1 \times .283$
$= 430$ LBS

ROD 3" DIA × 54" ; $\pi \times \frac{3}{4}^2 \times 54 \times .283 = 108$ LBS
4" DIA × 18" ; $\pi \times \frac{4}{4}^2 \times 18 \times .283 = 82$ LBS

MISC SAY 100 LBS

TOTAL WT = 480 + 430 + 108 + 82 + 100 = 1,200 LBS

3. FIND ACTUATING FORCE TO OPEN VALVE IN ~.04 SECONDS

ASSUME:
CONSTANT ACCELERATION
PRETRAVEL = 2 IN
OPENING TRAVEL = 16 IN

TRY $T = .05$ SEC & 18" TRAVEL (INCL. PRETRAVEL)

$S = \frac{1}{2} a T^2$ ; $a = 1200$ FT/SEC$^2$

ACTUATOR FORCE

$F = ma$

$= \frac{1200}{32.2} \times 1200 = $ 44,700 LBS

FIND VELOCITIES:

$V = aT$ (SEE BELOW)

FIND TRAVEL DISTANCES:

$S = \frac{1}{2} a T^2$

| S (IN) | T (SEC) | V FT/SEC |
|---|---|---|
| .72 | .01 | 12 |
| 2.88 | .02 | 24 |
| 6.48 | .03 | 36 |
| 11.52 | .04 | 48 |

TELEDYNE ENGINEERING CORPORATION

JOB MSFC VALVE CODE 1380 SHT NO. 3 OF 4 PKG 1

BY WBH DATE 7 JUNE 8?

COMPONENT SOLID SLEEVE REF ____ CK BY ____ DATE ____

SUBJECT VEL & DIST. VS TIME RV BY ____ DATE ____

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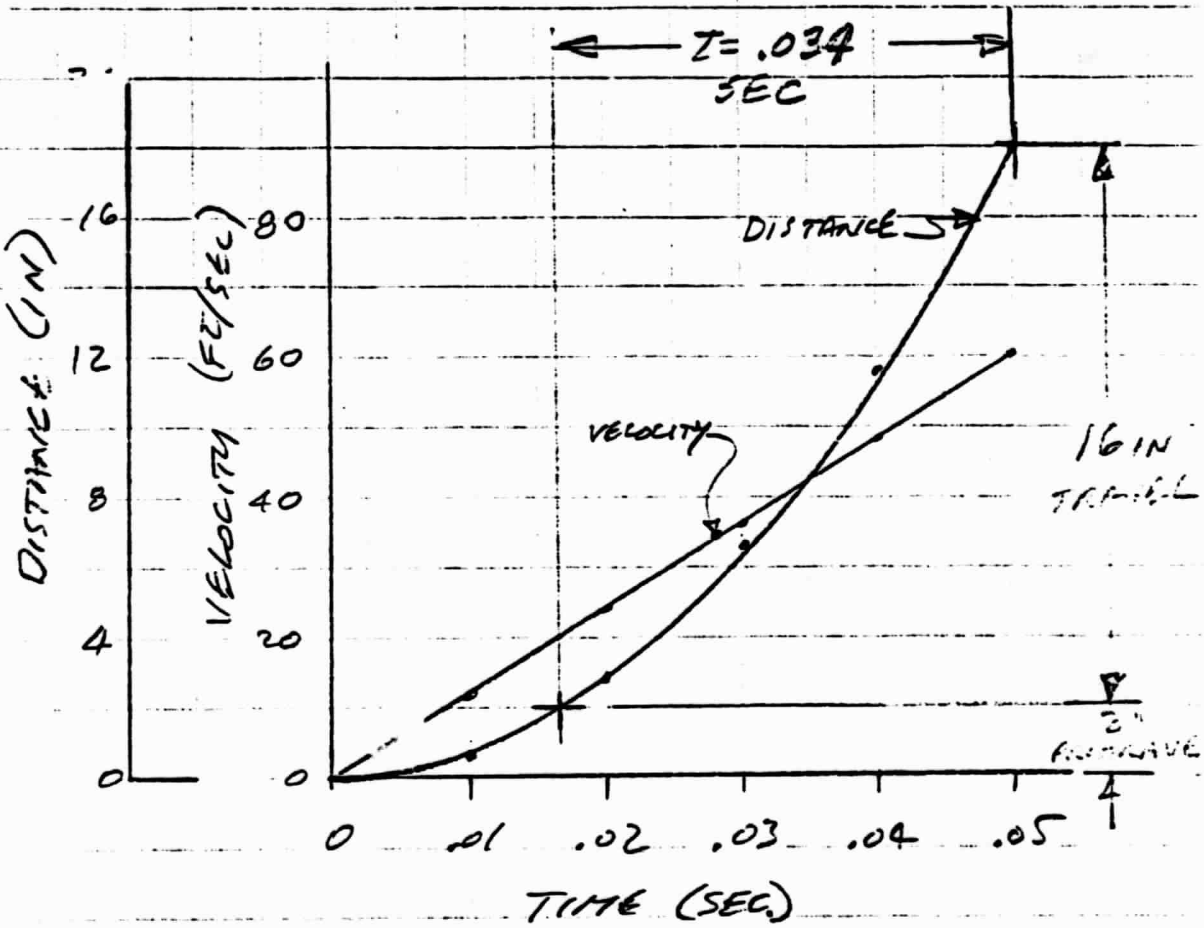
4. PLOT DISTANCE & VELOCITY VS TIME
(ASSUME CONSTANT ACCELERATION)



JOB MSFC VALVE CODE 1380 SHT NO 4 OF 4 PKG 11

BY WBH DATE 24 JUNE 83

COMPONENT SOLID SLEEVE REF

CK BY DATE

SUBJECT DEFLECTOR, STRUTS RV BY DATE



THE DEFLECTOR & BEARING STRUTS WERE SIZED BY INSPECTION. SUBSEQUENT DESIGN PRESSURES PROVIDED BY J.L.GRUNNET INDICATE LARGE LOADS ON THE DEFLECTOR. DURING DETAIL DESIGN, THE EXTENT OF THE DEFLECTOR MAY HAVE TO BE REDUCED TO LOWER THE LOADS.

THE SLEEVE STRUTS WERE ALSO SIZED BY INSPECTION, AND SUBSEQUENT DESIGN WILL HAVE TO CONSIDER DYNAMIC LOADINGS AS WELL AS PRESSURE LOADINGS FROM THE SLEEVE.

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

ACTUATOR

CALCULATION PACKAGE NO. 12

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 4 PKG 12
COMPONENT SOLID SLEEVE REF ____ BY WBH DATE JUNE 8:
SUBJECT ACTUATOR CK BY ____ DATE ____
RV BY ____ DATE ____

SIZE PISTON FOR DRIVING FORCE OF ~ 50,000 LBS & P = 650 PSI.

10" DIA PISTON; A = 78.5 $in^2$
3" DIA ROD; A = 7.1 $in^2$
71.4 $in^2$ NET.

FORCE = P·A = 650 × 71.4 = 46,400 LBS.
OK.

NOTE: MAX TUBE CHARGE PRESSURE IS 650 PSI. SINCE TUBE IS NOT ALWAYS CHARGED TO THIS PRESSURE, THE ACTUATOR MUST HAVE AN INDEPENDENT PRESSURE SOURCE, ie. USE A RESERVOIR AROUND THE PISTON/CYL.
ASSUME RESERVOIR CHARGE PRESS. IS ALWAYS CONSTANT & USE 650 PSI LEVEL FOR FIRST ANALYSIS.

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 4 PKG 12

BY WBH DATE 8 JUNE 8?

COMPONENT SOLID SLEEVE REF ____ CK BY ____ DATE ____

SUBJECT ____ RV BY ____ DATE ____



FIND FORCE REQ'D TO STOP MOTION:

ASSUME: CONSTANT DECELERATION

DISTANCE = 8"

WT = 1200 LBS

VEL = 60 FT/SEC

INERTIAL FORCE

$$a = \frac{V^2}{2S} = \frac{\overline{60}^2 \times 12}{2 \times 8}$$

$$= 2700\ FT/SEC^2$$

$$F = ma = \frac{1200}{32.2} \times 2700$$

$$= 101{,}000\ LBS.$$

IF ACTUATOR UTILIZES A CONSTANT DRIVING PRESSURE, THIS PRESSURE FORCE MUST BE ADDED TO THE INERTIAL DECELERATING FORCE

$\therefore$ TOTAL FORCE = 101,000 + 44,700

= 145,700 LBS

ENGINEERING CORPORATION

JOB MSFC VALVE CODE 1380 SHT NO 3 OF 4 PKG 12

BY WBH DATE 8 JUNE

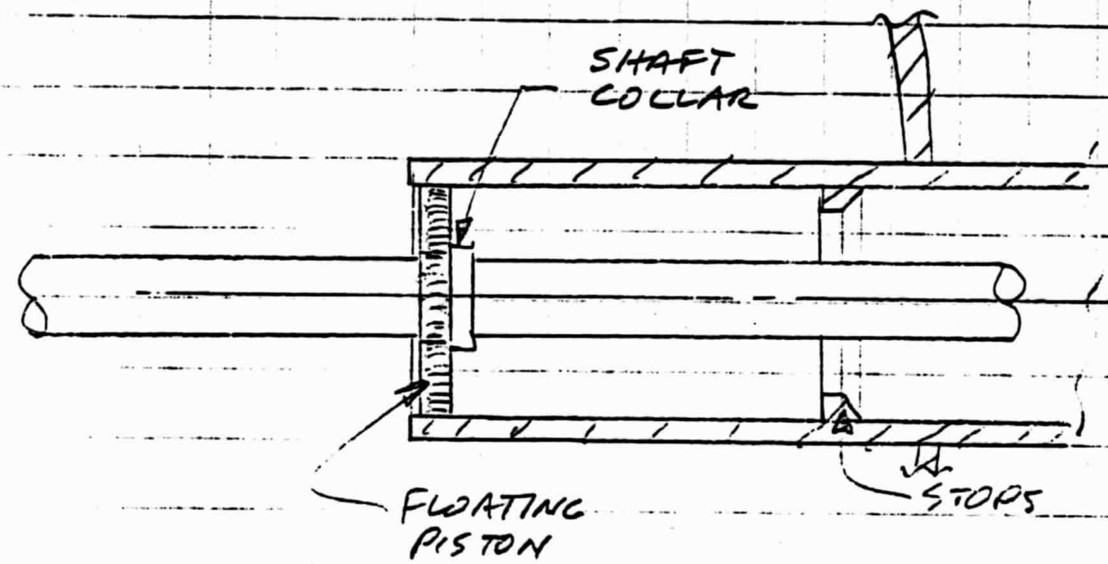
COMPONENT SOLID SLEEVE REF

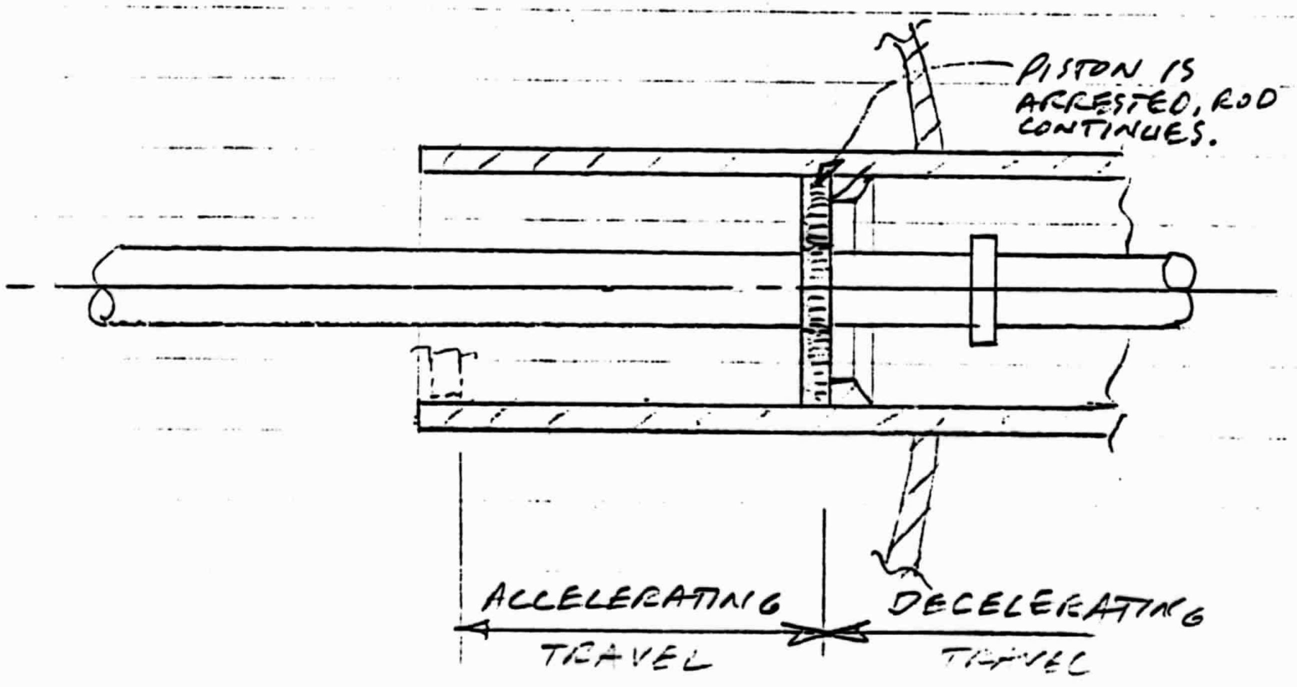
CK BY DATE

SUBJECT RV BY DATE



TO ELIMINATE THE ACTUATOR DRIVING FORCE DURING DECELERATION, CONSIDER A FLOATING PISTON:



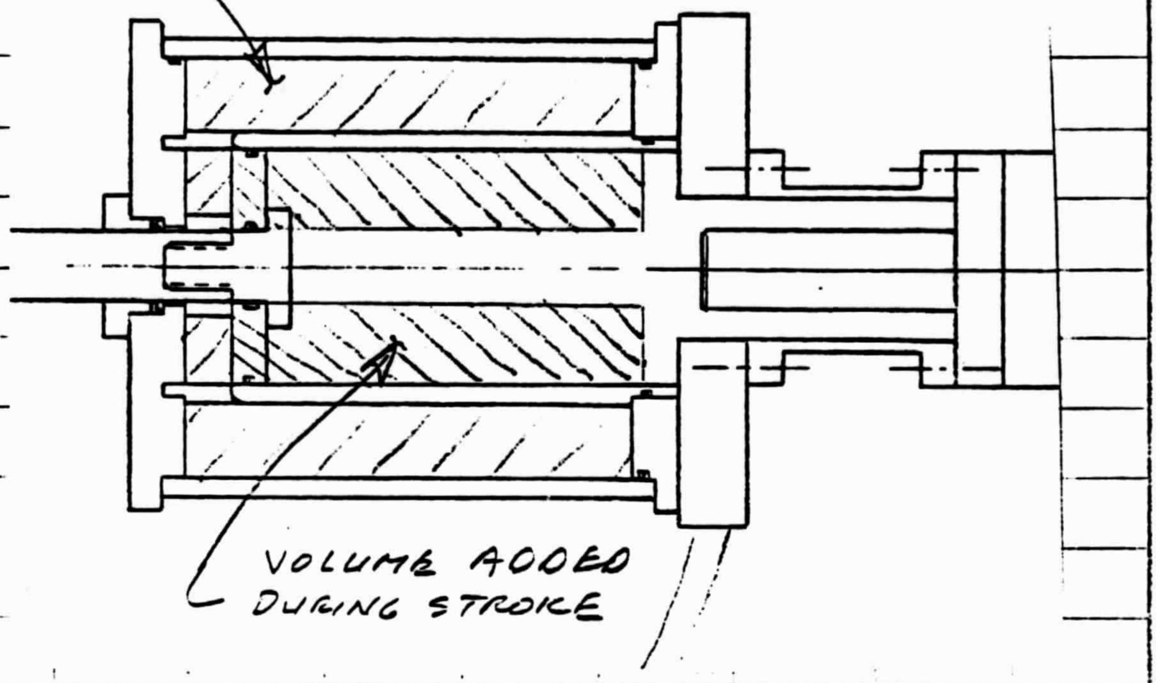
JOB 175FC VALVE CODE 1380 SHT NO 4 OF 4 PKG 12

BY WCH DATE 20 JUNE 83

COMPONENT SOLID SLEEVE REF ____ CK BY ____ DATE ____

SUBJECT ACTUATOR RV BY ____ DATE ____






INITIAL VOLUME:

$18''$ DIA; $A = 254.5$

$- 11\frac{1}{2}''$ DIA; $A = 103.9$

$150.6 \times 19.5 = 2937 \text{ in}^3$

$10''$ DIA; $A = 78.5$

$- 3''$ DIA; $A = 7.1$

$71.4 \times 2 = 143 \text{ in}^3$

$\Big\} \; 3{,}080 \text{ in}^3$

FINAL VOLUME:

$71.4 \times 18 + 3080 = 4{,}365 \text{ in}^3$

**FLUIDYNE ENGINEERING CORPORATION**

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

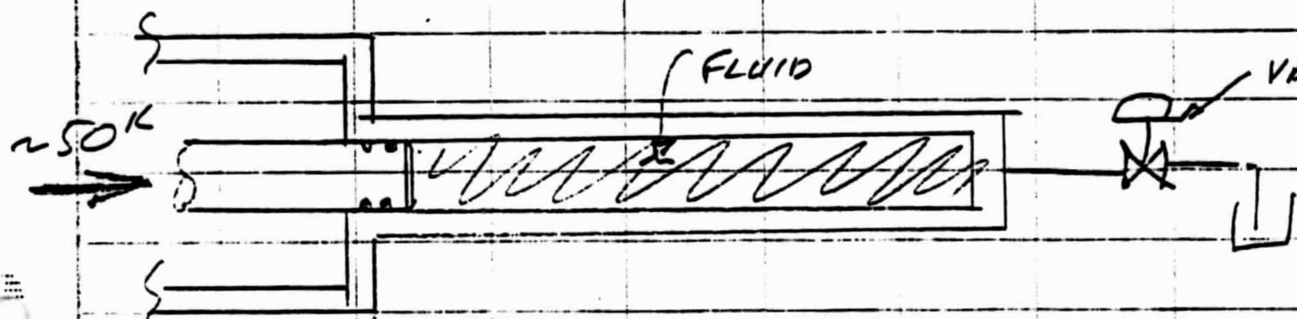
RELEASE MECHANISM

CALCULATION PACKAGE NO. 13

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 2 PKG 13
COMPONENT SOLID SLEEVE REF BY WBH DATE 1 JUNE 83
SUBJECT RELEASE / DECELERATION MECH CK BY ____ DATE ____
RV BY ____ DATE ____

ASSUME ACTUATOR DRIVING FORCE = $50^K$ LBS
CONSIDER USING TRAPPED HYDRAULIC FLUID & SPECIAL VALVE AS RELEASE/ DECELERATION MECHANISM




FLUID PRESSURE:

BEFORE RELEASE: $p = \frac{P}{A} = \frac{50{,}000}{7.07} \cong \underline{7{,}000\ PSI}$

DURING DECELERATION

$p = P/A = \frac{101{,}000}{7.07} = \underline{14{,}300\ PSI}$

HIGH!

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 2 PKG 13
BY WBH DATE 1 JUNE 83
COMPONENT SOLID SLEEVE REF
CK BY DATE
SUBJECT RELEASE / DECELERATION. RV BY DATE



CHECK HYD FLUID FLOW RATE AT MAX SLEEVE / ROD VELOCITY OF 60 FT/SEC:

$\dot{w} = A\ VEL$ $\quad in^2 \cdot \frac{ft}{sec} \cdot \frac{12\ in}{ft} \cdot \frac{60\ sec}{min} \cdot \frac{gal}{231\ in^3}$

$$= \frac{7.07 \times 60 \times 12 \times 60}{231}$$

$= \underline{1,320}$ GPM TOO HIGH!

THE VALVE & PIPING PRESSURE & FLOW REQMTS ARE TOO HIGH TO BE PRACTICAL.

CONSIDER ALTERNATE RELEASE & DECELERATION CONCEPTS.

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

DECELERATION

CALCULATION PACKAGE NO. 14

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

ASSUME:

WEIGHT OF MOVING MECH = 1200 LBS
MAX. VELOCITY = 60 FT/SEC
DISTANCE TO DECELERATE = 6 IN.

FIND KINETIC ENERGY

$$KE = \frac{1}{2} M V^2$$

$$= \frac{1}{2} \times \frac{1200}{32.2} \times \overline{60}^2$$

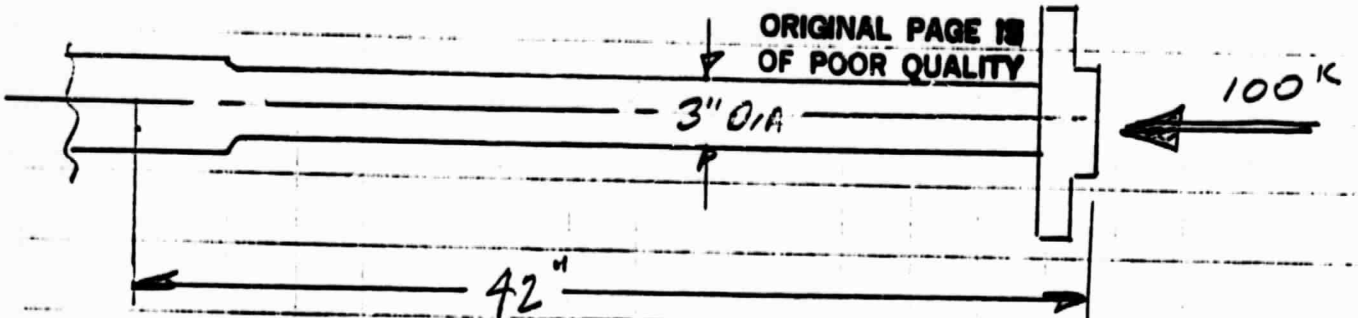
$$= 67{,}080 \text{ FT LBS}$$

OR 805,000 IN LBS.

REFER TO ACE CONTROLS, INC.
INDUSTRIAL SHOCK ABSORBERS
4" BORE x 8" STROKE - 800,000 IN LBS
MODEL SAHS
SELF CONTAINED, SPRING RETURN.
OR
5" BORE x 10" STROKE - 1,000,000 IN LBS
(PER ACE RECOMMENDATION TO SIZE
[illegible]

JOB MSFC VALVE CODE 1380 SHT NO 2 OF 2 PKG 14
BY WBH DATE 21 JUNE 8?
COMPONENT SOLID SLEEVE REF.
SUBJECT CHECK ROD BUCKLING @ DECELERATION CK BY DATE
RV BY DATE






$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right]F_y}{\frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}}$$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}}$$

AISC SPECS

$F_a$ = ALLOWABLE STRESS FOR COMPRESSION MEMBERS

FOR $\frac{Kl}{r} < C_c$

3" ROD ; $r = \frac{R}{2} = \frac{1.5}{2} = .75$

MAT'L = 4340

$F_y \cong 80{,}000$ PSI

$$\frac{Kl}{r} = \frac{1 \times 42}{.75} = 56$$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = 85$$

$$F_a = \frac{\left[1 - \frac{56^2}{2 \times 85^2}\right] 80{,}000}{5/3 + \frac{3 \times 56}{8 \times 85} - \frac{56^3}{8 \times 85^3}}$$

ACTUAL STRESS $= P/A = 14{,}200$ PSI

$= 33{,}400$ PSI. $> 14{,}200$ $\therefore$ O.K

**FLUIDYNE ENGINEERING CORPORATION**

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

TUNNEL MODIFICATIONS

CALCULATION PACKAGE NO. 15

| REVISION | DESCRIPTION | DATE | BY | APP'D |
| --- | --- | --- | --- | --- |

JOB MSFC VALVE CODE 1380 SHT NO 1 OF 1 PKG 15

BY WBH DATE 28 JUNE

COMPONENT REF

CK BY DATE

SUBJECT TUNNEL MODS. RV BY DATE

FIND CHANGE IN DIFFUSER LENGTH
FROM: TUNNEL ASSY DWG 80M53223
TO
FACILITY - LAYOUT SK 1380-704

ORIGINAL PAGE IS
OF POOR QUALITY

START WITH DIM. ON 80M53223

NOZZLE - O.K.

T.S. S.S. TO TRANSONIC

5'-4" TO 8'-4" = ADD 3'-0"

M.S. - OK

DIAPHRAGM - OMIT -3'-0"

SPOOL - OMIT -4'-10 5/8"

NEW SLEEVE VALVE - ADD +9'-0"

DIFFUSER - DELETE

(9'-0") - (4'-10 5/8") = -4'-1 3/8"

∴ NEW DIFFUSER LENGTH:

14'-9 3/8"
- 4'-1 3/8"
10'-8"

C-2

ALSO NEED TO RELOCATE O.S. COMPONENTS, EXTEND

FLUIDYNE ENGINEERING CORPORATION

QUICK OPENING VALVE - MSFC HIGH REYNOLDS NUMBER WIND TUNNEL

PRESSURE LOADS ON VALVE

CALCULATION PACKAGE NO. 16

| REVISION | DESCRIPTION | DATE | BY | APP'D |
|---|---|---|---|---|

JOB NASEC QUICK OPENING VALVE CODE 1280 SHT NO 1 OF PKG

BY [illegible] DATE 6/21/83

COMPONENT REF CK BY DATE

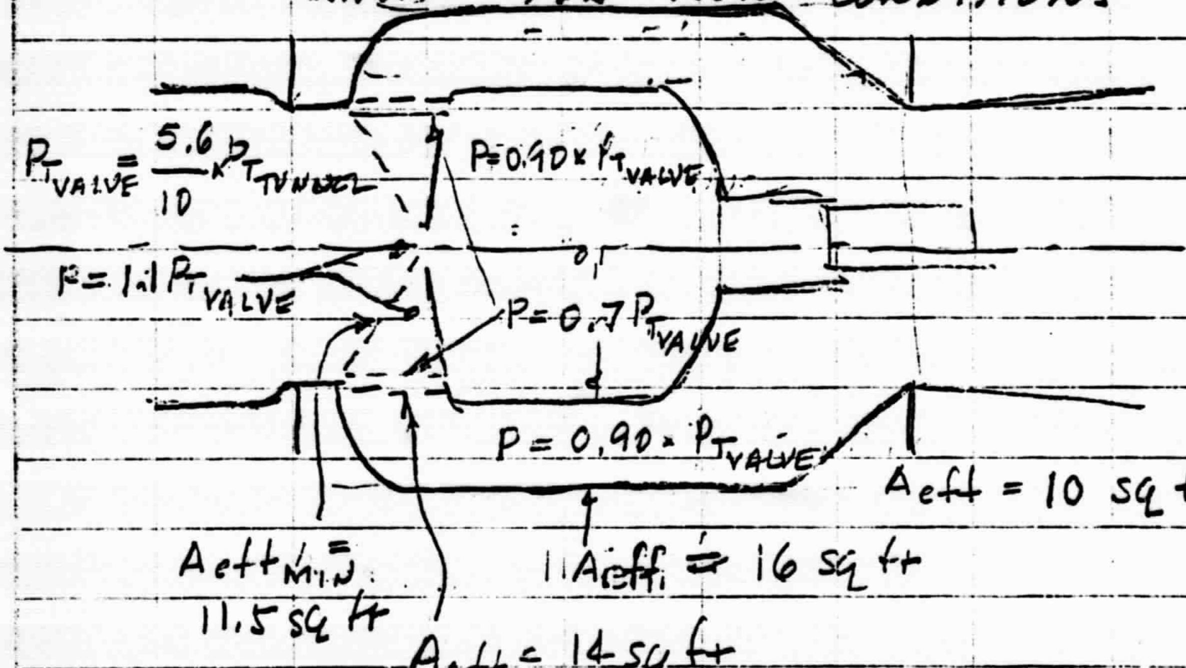
SUBJECT PRESSURE LOADS ON VALVE RV BY J.E.D. DATE 7/6/83

ESTIMATE PRESSURE LOADS ON VARIOUS PARTS OF VALVE STRUCTURE



GIVEN OR ASSUMED

1. TUBE DIAM 52"
2. TEST SECTION DIAM 32" ($A_{TS} = 5.6$ sq ft)
3. INITIAL CHARGE PRESSURE 665 PSIA
4. VALVE LAYOUT WITH OPERATING PRESSURE RATIOS FOR RUN CONDITIONS




CALCULATIONS:

$$\frac{A_{TUBE}}{A^*} = \left(\frac{52}{32}\right)^2 = 2.641$$

JOB ______ CODE 1380 SHT NO 2 OF ____ PKG ____

ORIGINAL PAGE IS OF POOR QUALITY

BY JLB DATE 6/21/8?

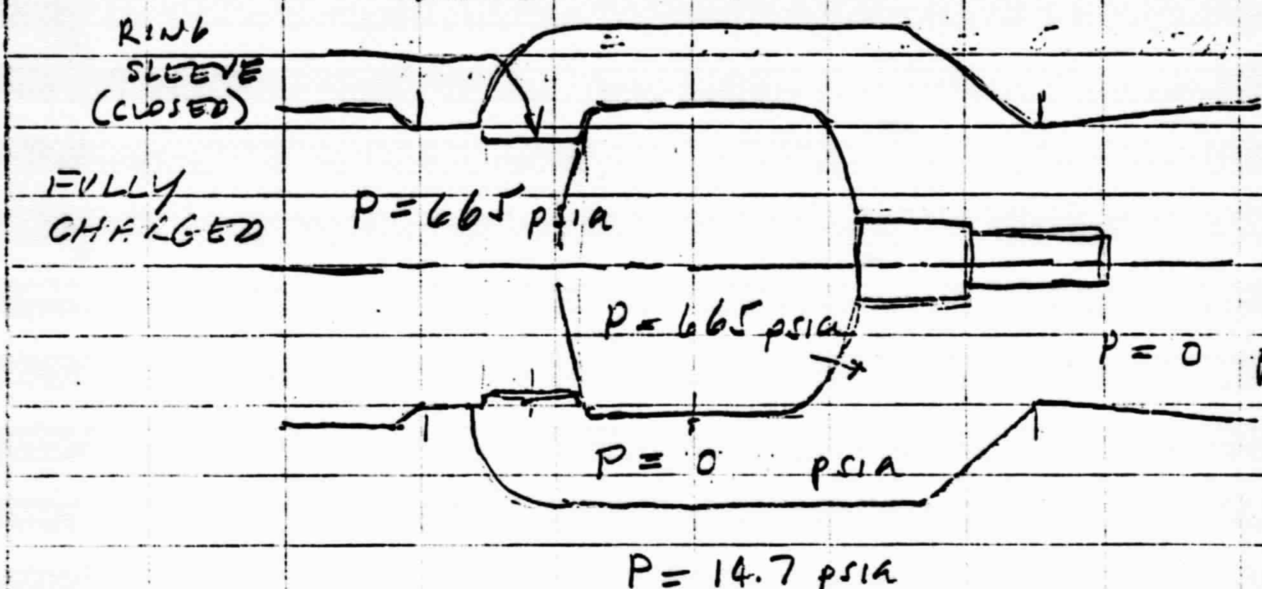
COMPONENT ______ REF ______ CK BY ______ DATE ______

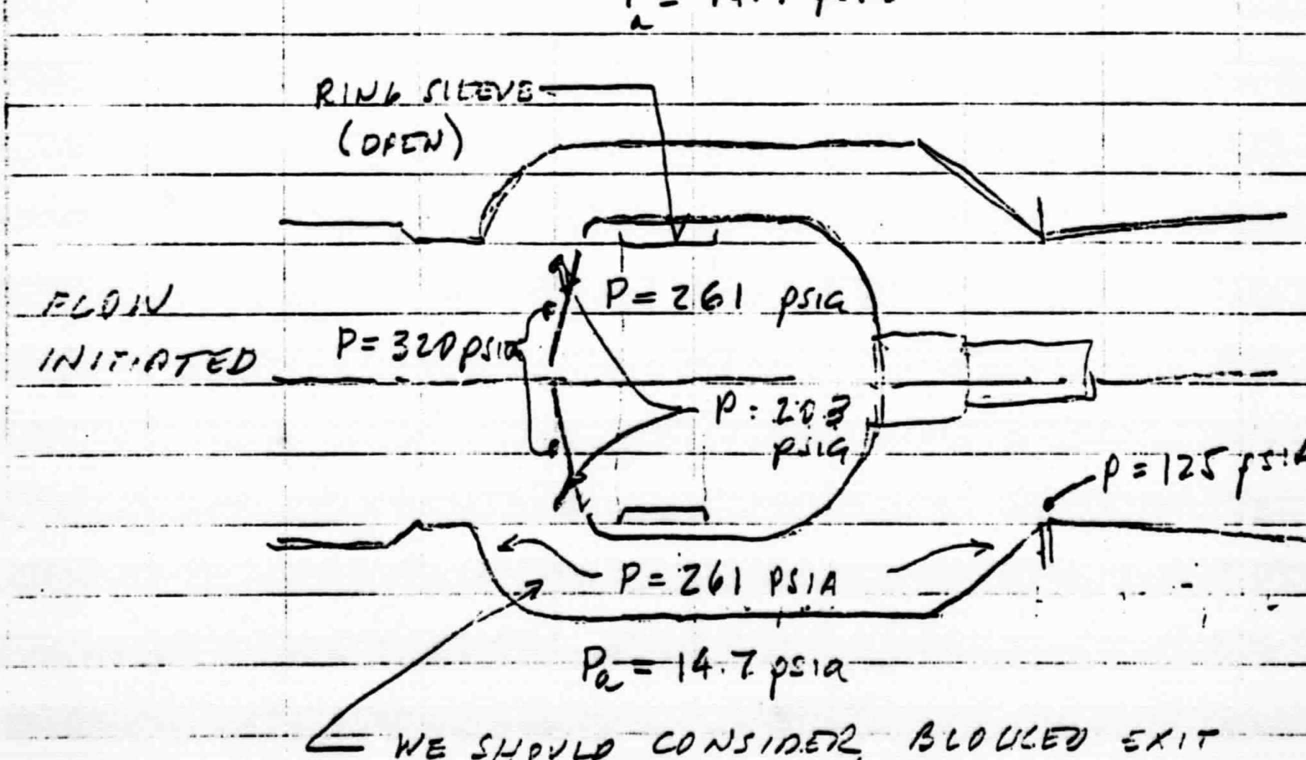
SUBJECT ______ RV BY JLB DATE 7/6/83

FROM AGARD REPORT 143 (TUBE TUNNEL)

$$\frac{P_{T\,TUNNEL}}{P_{CHG}} = 0.78$$

$$P_{T\,TUNNEL} = 0.78 \times 665 = 519 \text{ PSIA}$$




WE SHOULD CONSIDER BLOCKED EXIT